

METAL FINISHING

REPARATION, ELECTROPLATING, COATING

PUBLISHED FOR THIRTY-SEVEN YEARS AS METAL INDUSTRY



METAL FINISHING SERVICE FOR TODAY... *and Tomorrow*

There's no set pattern for the solution of today's metal finishing problems—whether caused by a shortage of raw materials, trouble shooting of existing over-worked equipment, change-overs to meet defense demands, or other unusual situations. However, regardless of what your plating difficulties may be, Hanson-Van Winkle-Munning will help solve them for today's defense necessities and tomorrow's market—by tried methods or new tailor-made equipment.

Our Sales Engineers are keeping in constant touch with conditions and changes. Our Research Department is experimenting with new methods and applications. The entire Engineering and Technical staff is available to help solve immediate problems.

Active and progressive research, development, manufacture and service have made Hanson-Van Winkle-Munning the "Plating and Finishing Headquarters"—the leaders in new developments of equipment and methods since 1870.



HANSON-VAN WINKLE-MUNNING CO.

MATAWAN, NEW JERSEY

PLANTS: . . . Matawan, New Jersey . . . Anderson, Indiana . . . Bridgeport, Connecticut

SALES OFFICES: Anderson · Bridgeport · Chicago · Cleveland · Dayton · Detroit · Elkhart · Matawan

Milwaukee · New Haven · New York · Philadelphia · Pittsburgh · Springfield (Mass.) · Syracuse

Manufacturers of a complete line of electroplating and polishing equipment and supplies

WE PLEDGE for 1942

OUR SERVICES 24 HOURS A DAY; 7 DAYS A WEEK



CLEPO FOR DEFENSE MANUFACTURE

ALUMINUM CLEANERS PRIOR TO ANODIZING
ALUMINUM CLEANERS PRIOR TO ENAMELING
BRASS SHELL FINISHING COMPOUNDS
STEEL SHELL CLEANERS • ARMS PARTS FINISHING COMPOUNDS
COMPOUNDS FOR FUZE AND BOOSTER CLEANING
CLEANING COMPOUNDS FOR BOMB CASINGS PRIOR TO ENAMELING
SPECIALIZED CLEANERS FOR USE PRIOR TO
PARKERIZING AND BONDERIZING



CLEPO FOR CIVILIAN MANUFACTURE

DEGREASING SUBSTITUTES
LONG-LIFE SOAKING CLEANERS
HIGH-SPEED ELECTRO CLEANERS

FREDERICK GUMM CHEMICAL COMPANY, INC.
538-542 FOREST ST., KEARNY, N. J.

Western Distributor: BELKE MFG. CO., 947 N. Cicero Ave., Chicago, Ill.

2

Founded as **METAL INDUSTRY**,
January, 1903 by
PALMER H. LANGDON
1868-1935

METAL FINISHING

VOLUME 40

JANUARY, 1942

NUMBER 1

Publication Office:
116 John Street, New York



L. H. LANGDON
Publisher

THOMAS A. TRUMBOUR
Business Manager

DR. WALTER R. MEYER
Editor

PALMER H. LANGDON
Assistant Editor

JOAN TRUMBOUR
Advertising Manager



PUBLISHED MONTHLY—Copyright 1942 by The Metal Industry Publishing Company, Incorporated, 116 John St., New York, N. Y. Entered February 25, 1903, at New York, N. Y., as second class matter under Act of Congress, March 3, 1879. Re-entered as second class matter June 13, 1940, at the post office at New York, N. Y., under the Act of March 3, 1879.

SUBSCRIPTION PRICES: United States, \$2.00 per year; Canada, \$2.50 per year (includes 50c exchange and tax). Foreign \$5.00. Single copies 25c. Please remit by check or money order; cash should be registered.

ADVERTISING RATES on application. Forms close the first of the month. Advertising copy should be mailed in time to reach us on or before the 20th of the preceding month.

METAL FINISHING reserves the right to investigate all products offered for advertisement, to refuse advertising considered unsuitable and to edit advertising copy when necessary.

CONTENTS

Editorial	1
Defense Highlights	2
Technical Developments of 1941—By Nathaniel Hall	3
Developments of 1941 in Hot Galvanizing and Hot Tinning—By Wallace G. Imhoff	12
Indium and Indium Plating—By M. T. Ludwick	13
Dupont Co. Opens New Laboratory	18
Industrial Hygiene at Work in Defense Industry—By Warren A. Cook ..	19
Metal Coatings on Non-Conducting Materials—Part II.—By Samuel Wein	24

Organic Finishing Section

Conditions During 1941 and The Outlook for 1942 in the Organic Finishing Field—By G. Klinkenstein	50
Coated Abrasives—a Tool—By E. B. Gallaher	51
Paint White for More Light—By James A. Meacham	58

DEPARTMENTS

Principles of Science Relating to Electroplating	26
Shop Problems	28
New Equipment and Supplies	29
Manufacturers' Literature	33
New Books	35
Associations and Societies	37
Obituaries	39
Personals	41
Business Items	42
Supply Prices	45
Post Scripts	46

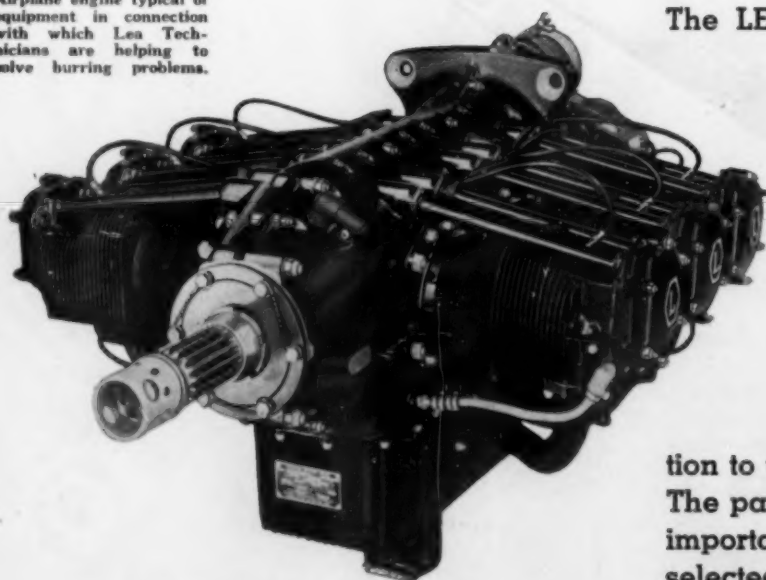
METAL FINISHING (formerly *Metal Industry*) has been the leading publication since 1903 in the field of metal preparation, electroplating and coating.

LEA FINISHING ENGINEERS

have worked out an economical solution to
YOUR BURRING PROBLEM

They're time-consuming and labor-wasting—those burring operations as now carried on in many plants with bench after bench of workmen removing excess metal with hand files, burring tools, emery cloth, etc. And it's a tricky job to maintain proper tolerances and measurements when using such tools.

Airplane engine typical of equipment in connection with which Lea Technicians are helping to solve burring problems.



The LEA Method, now in use in a number of important plants manufacturing materials for defense including plane and engine parts, machine gun assemblies, etc. embodies the selection of the ideal combinations of special types and shapes of buffing wheels with the proper grades of Lea Compound.

In writing for further information, give full details of the burring operation to which you wish to apply the LEA Method. The part, metal and nature of operation have an important bearing on the buff and composition selected.

THE LEA MANUFACTURING CO.

Waterbury, Conn.

Specialists in the Production of Clean-Working Buffing and Polishing Compounds

Plating in the War Program

THE plating and finishing operations under the war effort are greatly different from those in peacetime. The decorative value of finishing has been largely neglected in deference to other features such as weather resistance, wear resistance and resistance to chemical attack. The metals being plated in larger relative proportions will be silver, zinc, cadmium and heavy chromium. There will be an increase in indium plating, heavy iron plating and lead plating as well as much wider use of anodizing processes, phosphate treatments and chemical oxidizing processes. The plating of nickel, copper, decorative chromium and tin will decline although the plating of copper and brass will hold up until the expected large decrease in non-defense goods production occurs. This is a result of allowing the use of copper for plating equal to 5% of the weight of copper of articles under the M-9-c order. There is also hope that extensive copper plating may be done on projectiles.

Silver in the war program is now being plated largely for electrical contact purposes. In most cases the thicknesses are much greater than those of decorative silver. Thicknesses of silver of the order of 0.003" are being specified, and because of the relatively slow rate of silver deposition, there have been many instances of increasing silver plating capacity. There will also be a great increase in the use of silver for decorative plating because silver is still plentiful. Silver plating of steel strip as a substitute for tinning has long been investigated.

The use of zinc and cadmium for protecting steel is general in the War Program and the plating of these metals, obviously, will be continued.

Heavy chromium plating is increasing amazingly. It is being used for wear and corrosion resistance in cylinders of diesel engines,

on guns, moving parts on airplane engines, and for many types of gauges, drawing and molding dies. With the urgent need for longer life of the products mentioned, the use of heavy or "hard" chromium will expand greatly.

The electroplating of indium and silver-lead alloys is being done particularly for airplane engine bearings, and is being expanded to automotive vehicles such as trucks. Indium plating is discussed in detail in this issue and the investigation of its merits are recommended.

Heavy iron plating is expanding for use in building up worn parts, the making of dies electrolytically, the plating of type in place of nickel, and the coating of copper soldering iron tips. This last-named use is particularly important because of the savings in copper and of labor in soldering and repairing of corroded tips. Copper soldering iron tips plated with 0.030" of iron have given service lives from 300 to 500 hours as contrasted with 3 to 5 hours for a plain copper tip.

Chemical and electrochemical oxidizing and protective processes are being used on an increasing scale. These include chromic acid and sulfuric acid anodizing of aluminum, phosphate treatments for steel and zinc, chemical treatments for magnesium, and chemical blackening of steel.

In addition to the war plating work mentioned, there will be considerable plating for essential non-defense goods. The recently announced armament production, gigantic as it is, will not require complete cessation of production of washing machines, vacuum cleaners, hardware, clocks, bicycles and plumbing goods. Plating has suffered and there may be great readjustments in the type of plating, but the War Effort does not mean the eclipse of the plating industry.



Defense Highlights



Synthetic para-cymene is now being made on a commercial scale from liquid terpenes by the Hercules Powder Co., at Brunswick, Ga. This important chemical is used as an intermediate in the manufacture of phenols, thymol and menthol, the last named chemical having been imported in large quantity from Japan.

The use of chromium steels containing more than 4% chromium was restricted in Supplementary Order M-21-d. The Order does not apply to fully fabricated chromium steel articles but to such material in a stage of fabrication.

The importation of thirteen materials has been placed under the control of the Federal Government. These materials are: antimony, cadmium, chromium, copper, graphite, kyanite, lead, mercury, rutile, tungsten, vanadium, zinc and zircon. In addition to helping to maintain adequate supplies of these materials for war production, it is believed that a greater flow of them from present war zones may be made possible as the Metals Reserve Co. can take risks on delivery which a private importer might not want to face, and closer cooperation with the Maritime Commission for shipping space can be had.

The facilities for production of synthetic rubber are to be tripled according to plans recently approved by SPAB. Present facilities of production of synthetic rubber are approximately 10,000 tons a year and productive facilities for synthetic rubber now under construction will have a capacity of 40,000 tons a year, and the projected expansion program will give the nation an annual production of 120,000 tons of synthetic rubber, which is about one-fifth of the rubber normally consumed in a year by the United States. Ninety-eight per cent of natural rubber used by us is imported from the region in the Far East, now engaged at war.

World production and consumption of nickel in 1941 were at an all-time high. The United States consumed over two-thirds of the world's total nickel output in 1941 as contrasted with an average annual consumption of about one-third during recent years. Steel mills are using 70% of the U. S. consumption, foundries 7.3%, brass mills 6.5%, heat and electrical resisting alloys 4.6%, and electroplating 2.5%. The International Nickel Co. has undertaken a production expansion program to be completed in 1943, which will increase annual nickel production capacity by 50,000,000 pounds.

Manila fiber and cordage were placed under drastic restriction by General Preference Order M-36.

The production of citric acid was menaced by the attack on Hawaii. It is not generally known that Hawaii is a producer of citric acid from pineapple juice, and a substantial portion of this material comes from Hawaii.

Priorities Division of OPM has pointed out that retail consumers cannot and must not be expected to produce preference rating certificates, when placing normal orders for finished goods not under any form of control. This announcement was made particularly in reference to farm machinery and privately-owned automobiles and trucks.

The use of iridium and its alloys in the manufacture of jewelry except when specific permission is given, was prohibited under Conservation Order No. M-49, issued December 12, 1941. The use of ruthenium alloys in place of iridium has been recommended.

A \$10.00-drum charge made by the seller upon the customer has been stated by OPM not to be a violation of the ceiling prices placed on drums. The decision was based upon the viewpoint that actual sale of the drum is not involved and the price charged is merely to insure return of the drum to the seller.

Restrictions on shipments of glycerin were made in an order issued by OPM on December 10th and in addition, reports of glycerin stocks were requested. Coconut oil, from which much of our glycerin is made, comes largely from the Philippines. Glycerin is an important ingredient in the manufacture of explosives.

All supplies of tin in the United States and all tin afloat were placed in charge of the Federal Government by General Preference Order M-43, issued December 18, 1941. The Order provides that all supplies of tin shipped are subject to specific allocation by the Director of Priorities and the purposes for which tin is used shall also be specified. No tin can be sold or delivered without the specific permission of the Director of Priorities. The only exception to the Order is that a distributor may deliver to his customers less than 5-ton lots of tin, subject to Priorities Regulation No. 1. Approximately a year's supply of tin at normal demand levels is now at hand in the United States.

Technical Developments of 1941

NATHANIEL HALL

Consulting Chemical Engineer,
G. B. Hogaboom, Jr. & Co., Newark, N. J.

Theoretical

ALTHO the year 1941 produced no contribution along theoretical lines to compare with Kasper's paper of the previous year on the mathematical derivation of the path of current through solutions in which anodes and cathodes of various contour are immersed, a number of interesting accomplishments were reported in the literature.

Continuing their work on electrolytic films, Read & Graham¹ modified their original method of *sampling electrode films* by substituting an insulated sampling hole in the electrode. The results by this method of sampling were about the same as by the original method. They also found that the composition of the film samples was influenced by the size of the sampling hole and that even with the slowest sampling rates the absolute composition of the film was not obtained. Brenner², also continuing his work on the same subject, improved his previously reported freezing method for isolating cathode films, by using isopentane chilled by solid carbon dioxide, followed by liquid air, instead of solid carbon dioxide and a mixture of chloroform and carbon tetrachloride, thus obtaining a temperature of -163°C . instead of approximately -80°C . As a result he was able to freeze the cathode film in about 0.8 second instead of about 2.3 seconds. The results of these tests using various plating solutions were described, as were the results using the drainage method, in which the drag-out film is collected and analyzed. The film was found to have a thickness of approximately 0.002".

Lorch³ extended the previously reported studies of the electrochemical *polarization of the hydrogen electrode* and showed that the reaction of oxygen at the electrode is diffusion controlled even on the weakest platinum and iridium catalysts. A detailed study was made of the diffusion process.

Hickling & Salt⁴ studied the influence of the presence of oxygen, variations in acid concentration and nature, temperature and catalytic poisons on *hydrogen overvoltage* at high current densities. They found that oxygen may be without effect at high current densities, and that the effect of temperature varied with different electrode materials, as did the effect of poisons. Concentration and

The author presents a comprehensive survey of the technical literature and patents on subject matter pertaining to the finishing industry. Because of the vast amount of material covered, no subject matter is discussed at length and the original literature is suggested for complete details. The superior numbers refer to the corresponding references listed on pages 10 and 11.



Nathaniel Hall

type of acid had little effect except when concentration polarization occurred.

Thompson⁵ reviewed some of the *properties of the cyanide plating baths* of the heavy metals, based on the probable constitution of the complex metalocyanides which are in solution. The available information on the constitution of the complexes was summarized and emphasis was laid upon the fact that the metalocyanides constitute a group of coordination compounds.

Engel⁶, using a two cathode arrangement in acid copper baths, showed that the *ratio of the current densities* on the main and secondary cathodes decreased with increasing distance between the cathodes and with increasing current to the main cathode, especially at small spacings. The ratio was found to be independent of the distance from the anode over a wide range.

Hartshorn⁷ explained the *action of surface tension depressants*, including in his paper a review of the different chemical types and their characteristics. The orientive state of polar-non-polar compounds at liquid interfaces was considered in detail together with the relation between the molecular structure and wetting action.

The different types of *iron rust* were discussed by Imhoff⁸ who listed the conditions under which they are formed, their probable formulas and their physical characteristics. He followed this by explaining the chemical theory and the electrolytic theory of corrosion involved in the mechanism of rusting, pointing out that the chemical and electrolytic theories are basically the same in that they both depend on the mechanism of ionization.

Hogaboom⁹ suggested that when reporting *throwing power* results, the conditions involved in the determinations, such as specific resistivity of the solution, distance between electrodes, metal used as cathode, addition agents, etc., should be given.

Conley¹⁰ presented a paper on *fundamental metallurgy* and its relation to the practical application of alloys which, in simple terms, could be considered as a new interpretation of "what is under the plate."

Anodizing and Corrosion Prevention

ALTHO the field of anodizing and corrosion prevention was not covered in any great lengths in papers presented during the year, this field accounted for a greater number of patents than any other phase of metal finishing.

The effect of copper on the protective power of *anodized films on cast aluminum alloys* containing copper was studied by Hostetter, Van Winkle & King¹¹ who found that the rate of corrosion was increased with increasing copper content and that anodizing rendered the cast alloys, which had not been heat treated, more resistant to salt spray corrosion. Edwards & Keller¹² used x-ray and electron diffraction methods to determine the *structure of the anodically formed oxide coatings* on aluminum in dilute solutions of sulfuric, oxalic, chromic and boric acids, finding them to be amorphous. They

also discussed the characteristics of the various solutions.

Holman¹³ compared the operating data of the sulfuric acid and the chromic acid anodizing processes, listing the advantages, limitations and applications of the two processes. Mozley¹⁴ discussed the chromic acid process and the mechanism of the formation and nature of the oxide film. He also reported on the methods of maintenance and control at Lockheed Aircraft Corp. Results of his tests indicated that the relation between free chromic acid, determined by pH measurement, and the condition of the bath does not hold. Although specifications call for at least 5% chromic acid, they found that lower figures gave better films. (Authors' note: Latest specifications allow the use of any satisfactory process for anodizing aluminum, as long as the films produced pass the required tests).

Patents were granted to Schenk covering anodizing processes using solutions of thorium salts and oxygen containing anions¹⁵, solutions of zirconium sodium oxalate, borax, boric acid and dextrine¹⁶, and solutions containing titanium ions and acids¹⁷. Buzzard¹⁸ patented a solution comprising dichromate and phosphate, followed by a sealing treatment consisting of anodizing in a solution of a chromate, dichromate, fluoride or borate. Muller & Korpiun claimed a solution containing a heavy metal such as tungsten and an acid¹⁹, while Korpiun patented a process using alternating current in a sulfonic acid solution containing a sulfate²⁰.

In connection with the treatment of magnesium and its alloys, Wray²¹ reported that by proper selection of the alloy, the surface treatment and the painting treatment, it has been found possible to obtain satisfactory protection on magnesium alloys for several years, even under severe service conditions. Buzzard²² patented an anodizing solution for magnesium and its alloys consisting of a trivalent chromium salt and a chromate or dichromate. He also patented a solution containing borate and chromate or dichromate²³.

Corrosion resistant films on magnesium was the subject of patents issued to DeLong & Reid²⁴ involving subjection of the article to a solution of sodium carbonate under pressure and at elevated temperatures, and to Beck, Siebel & Nachtigall²⁵ who claimed a similar process but using materials such as potassium abietate solutions and potassium naphthenate solutions.

Michel & Henneberger were granted a patent on an anodizing process for magnesium which used a solution of a fluoride and glycol in water²⁶. Thompson developed a process for protection of aluminum²⁷ by applying an acid phosphate and fluoride solution to the articles and allowing it to dry on.

Attack on tin cans used in sulfur-bearing food packing was found to be prevented by treatment of the tin plate with a hot solution of potassium dichromate and trisodium phosphate with a small amount of wetting agent and hexametaphosphate added to cut down the time required. This treatment was found to passivate the iron exposed at the pores in the tin coating²⁸.

Treatment of steel and other ferrous alloys to form rust resisting films was discussed by Darsey²⁹, covering the phosphate treatment of steel automobile bodies before painting and including the chemical reactions involved and the testing of the coating by humidity and salt spray methods. The films formed during rustproofing steel were studied by Halls³⁰ who reported that the smut does not affect adhesion but increases porosity and roughness of the subsequent finishes. Since the loose coating appeared to affect the rustproofing qualities very little, the author recommended that light smuts be ignored, that heavy smuts be removed and that intermediate smuts should be disregarded for multi-coat finishes but wiped off for single-coat work. Patents were granted in connection with the rustproofing of ferrous alloys to Neilson³¹ for a composition containing water, phosphoric acid and a wetting agent, to be followed by dilute ammonia, to Castner³² for a process which comprised application of a nitrate solution which was allowed to dry on the work, to Shoemaker³³ for a rinse, subsequent to pickling, in a solution containing an alkali, a polyhydric alcohol such as glycol or glycerine and a wetting agent, to Becker & Steinberg³⁴ for a treating process at elevated temperatures with a gaseous mixture of hydrogen and chromous chloride, and to Romig³⁵ for an acid zinc phosphate solution containing hydrogen peroxide followed by a chromic acid dip.

Lodeesen³⁶ claimed the retardation of corrosion of copper and its alloys by immersion in an acid phosphate solution containing a metal of the zinc group and an oxidizing agent followed by a chromic acid rinse.

The protection of zinc by subjection to a solution such as formic acid plus a metal accelerator in the form of a soluble salt was the subject of a patent issued to Thompson and Hanson³⁷. A patent issued to Nelson & Herro³⁸ claimed the prevention of corrosion of tin plate material in contact with food products by exposure of the tin plate to a strong sulfidizing agent at elevated temperatures.

Two patents were claimed to be applicable to a number of different metals, such as iron, copper, aluminum and their alloys, one issued to MacKay³⁹ consisting of subjection to a molten mixture of an alkali metal nitrate, an alkali metal hydroxide and manganese dioxide followed by fixing or neutralization in a dilute acid solution, and the other to Thompson & Goodspeed⁴⁰ comprising subjection to vapors of chromic acid and a chloride at elevated temperatures.

Polishing

IN CONTRAST with 1940, the past year's efforts were directed more along the lines of mechanical rather than electrolytic polishing, probably because of the scarcity of stainless steel which is the material most generally electropolished. No patents were issued and only a few articles were published on electropolishing. Faust & Pray⁴¹ investigated the sulfuric acid-phosphoric acid mixtures and determined that the baths

containing 15%-40% sulfuric acid and 67%-44% phosphoric acid with some water were very satisfactory for electropolishing stainless steel, and that the addition of small amounts such as 0.5% chromic acid improved the action. Uhlig⁴² studied solutions of phosphoric acid and glycerine in water and showed that a solution containing by weight 42% phosphoric acid, 47% glycerine and 11% water at 100° C. or higher and with a current density of at least 0.1 amp./sq. in. was suitable for electropolishing 18-8 stainless steel. Meyer, Rahrer & Vilella⁴³ described electrolytic polishing as applied to steel and stainless steel for microscopic examination.

Mechanical polishing methods for the preparation of steel specimens prior to plating for exposure tests were described by Lux⁴⁴, the Research Associate of the American Electroplaters' Soc., who also described the measurement of the degree of finish obtained. Hogaboom, Jr.⁴⁵ outlined the procedures followed in lapping metals on a metal lap, discussing the compositions of the laps and the lapping compounds. The importance of proper adhesives was pointed out by Callahan⁴⁶ who stated that the output from coated abrasives could be increased by 20% by proper attention to the factors which generally cause failure such as improper storage conditions and incorrect humidity. Siefen⁴⁷ listed the data on silicate of soda base cold cements in connection with polishing procedures.

Patents were granted on improved buffing wheels to MacFarland & Krugloff⁴⁸, Peterson & Peterson⁴⁹, Barton & Barton⁵⁰, Hawkinson⁵¹, Thompson⁵², Hendrickson⁵³ and Thomas⁵⁴. Twynning⁵⁵ patented a buffing compound with a binder of stearin pitch, and a few mechanical patents on methods for applying polishing compounds may be found in the patent literature.

Cleaning

THE methods and solvents applicable to the cleaning of munitions such as shells, cartridges, guns, rifles and other materials were reviewed by Mitchell⁵⁶, while Zinty⁵⁷ did the same in connection with the equipment and techniques used by munitions manufacturers in Europe before and shortly after the outbreak of the war.

Promisel⁵⁸ discussed the design and proper operation of degreasing equipment, from the standpoint of efficiency and minimum health hazards. The specifications of the New York Labor Dept., Division of Industrial Hygiene, for exhausting degreasers were given, and it was mentioned that 120 cubic feet of air should be exhausted for each square foot of tank surface area.

The various films on steel formed by the decomposition of the coolant during the cold rolling of steel were described by Lyons⁵⁹. He suggested that thermal decomposition of the coolant oils on the strip was responsible for the very resistant films sometimes formed. Adsorption of fatty acids might also be troublesome, it was stated, and the author concluded by indicating the best conditions for electrolytic removal of oil and dirt. Thomas⁶⁰ checked the attack of weak alkaline cleaners on aluminum and determined that for use with

this metal, the alkaline cleaners should contain about 25% sodium metasilicate for minimum attack.

Noble⁶¹ published the results of several years of study of the quantitative determination of the effect of *hydrogen embrittlement* as produced by various commercial cleaning and plating solutions. He reached many interesting conclusions among which were that susceptibility to hydrogen embrittlement increases generally with hardness. A maximum occurs at a range of 500-550 Brinell except in steels which are not subject to a temper brittle range. Susceptibility also increases with the hardening constituents, primarily carbon. He also found that hydrogen embrittlement tends to dissipate on standing at room temperature, and can be hastened by heating, confirming the findings of previous investigators. Complete relief depends on the embrittling medium and the type and thickness of the plate. Temperature is a much more potent factor than time in relief treatments. Embrittlement increases with decreased section, and in heat treated steel, is negligible in most cases when heat treated to 40 Rockwell "C" or less. For cold worked steel, a lower hardness limit was found.

Various cleaning processes and detergent compositions were patented during the year. A process for removing the black scale formed on aluminum and aluminum alloy engine parts, comprising immersion in oleum, followed by a rinse in 60% sulfuric acid, was patented by Abrahams⁶². Orozxo⁶³ patented a method of dirt and grease removal which involved heating the metal article above the boiling point of water, in an oil bath, and then transferring immediately to a boiling alkaline detergent solution whereby the high heat of the article results in complete combination of the cleaner with the grease and dirt. A more interesting and probably more practical invention was the subject of a patent granted to Matteson & Bowman⁶⁴, who claimed a process for continuously cleaning strip metal which consisted of generating heat in the strip itself as it passed through the cleaning bath, whereby boiling occurred adjacent the surfaces of the strip.

Reed⁶⁵ patented a detergent composition consisting of 35%-90% by weight of a water soluble alkali metal salt of a mineral acid and the balance a surface active product prepared according to a method described in the patent. Vail⁶⁶ patented a detergent comprising particles of an expanded alkali metal silicate combined with at least 5% of an alkali metal soap formed in situ. A finely divided dry detergent composition comprising a water-soluble normally dry alkaline reacting detergent and a solid diluent comprising an inorganic aerogel which acts as an anti-caker and as an emulsifier when the composition is dissolved in water was claimed in a patent issued to Curtis⁶⁷, and finally Salz⁶⁸ was granted a patent on a liquid metal cleaner consisting of water, oxalic acid, potassium dichromate and glycerine in specified proportions.

Barrel Finishing

BEAVER continued his monthly articles on barrel finishing and seemed to have the

whole field to himself. Among the features he covered were abrasive finishing in barrels and how it differed from sand blasting⁶⁹, the proper method of loading burnishing barrels⁷⁰, precision operation for grinding to size⁷¹, a comparison between barrel finishing of electrodeposits and manual polishing⁷², the importance of specific gravity in the burnishing of metallized plastics⁷³, the use of leather scrap for barrel finishing⁷⁴, and the use of lignum vitae wood shapes for burnishing light materials⁷⁵.

Pickling

THE effects of *hydrogen absorption* at ordinary temperatures, during pickling, on surface defects in applied coatings were studied by Zapffe & Sims⁷⁶. Increasing acid pickling temperature from 20° to 80° C. was found to increase the hydrogen absorption thirty fold. The ratio of liberated to absorbed hydrogen, however, was increased about five fold, so that in view of the shorter pickling time at higher temperatures, less hydrogen was absorbed by the metal in a given time. The authors also discussed the effects of inhibitors, cathodic electrolysis, current density, promoting metals and other factors.

Damon⁷⁷ investigated the *acid corrosion of steel* and found that high carbon steels corrode more readily in sulfuric acid than low carbon steels. Steel between 0.06% and 0.37% carbon had the lowest corrosion rate for all strengths of acid. The maximum corrosion for all steels was in acid having a normality of 11 to 14. All types of steel became passive in acid over 17 normal in concentration. The passivating film was shown to be ferrous sulfate.

The advantages of the *use of wetting agents in pickles*, with resulting lowered surface tension were pointed out by Hartshorn⁷⁸ to be more uniform pickling, less acid consumption, less attack on the basis metal and reduced spray. An *acid pickling inhibitor* consisting of a mono-aminated phenyl-diphenyl oxide composition was patented by Britton & Alquist⁷⁹.

Ostrosky⁸⁰ was granted a patent on a *pickling process for chromium iron alloys* which involved treatment in fused caustic at 25 amp./sq. ft. first as cathode, then as anode and finally as cathode again. Hilty⁸¹ claimed a process for *pickling silicon steel* comprising subjection to an acid solution containing sulfur dioxide, and Kalischer⁸² patented a *pickling process for nickel bearing ferrous alloys* requiring an alternating current treatment in dilute sulfuric acid solutions.

Pickling compounds which could be handled in dry or paste form and mixed with water for use were patented by Johnson⁸³ who claimed a composition comprising the reaction product of urea sulfate and a water soluble metal chloride, the mixture being capable of releasing hydrochloric acid when mixed with water, and by Humphrey & Lee⁸⁴ for aluminum comprising phosphoric and phosphorous acid, a fluoride and colloidal clay.

The *treatment of spent pickle liquors* was the subject of two patents. Abbot⁸⁵ sug-

gested the addition of magnesium hydrate to form a slurry which was dehydrated and from which the iron hydroxide was separated by dissolving the magnesia in water, after which the magnesia was recovered and re-used. Clarkson⁸⁶ patented a method of treating the crystallized ferrous sulfate from waste pickling liquors to obtain ferric oxide and sulfuric acid by high temperature decomposition and oxidation of the liberated sulfur dioxide.

Coatings

GENERAL

NOBLE'S work on the effect of various cleaning and plating solutions on *hydrogen embrittlement* has already been referred to above⁶¹, as has the contribution of Zapffe & Sims⁷⁶ on the effect of hydrogen absorption on the applied coatings.

Shortages in materials due to unprecedented defense requirements focused attention on a number of articles. Blum⁸⁷ discussed the methods possible, during the present shortages of metals, for protecting equipment against corrosion by plating. Griggs⁸⁸ listed the various improvements in metal finishing practice instituted as a result of munitions requirements.

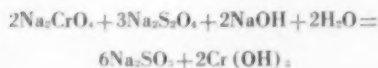
The *Corronizing process* was described by Rimbach⁸⁹ as consisting of a nickel plating followed by a zinc or tin plating operation followed by heat treatment at 500° to 750° F. Salt spray comparisons between this type of coating and galvanized coatings on 22 gauge steel sheet indicated that for initial failure at 60 hours exposure to the spray, only about one-sixth the total thickness of deposit was required while for 500 hours, only about one-tenth was required. For example, it was claimed that for the 500 hour salt spray, 0.00009" of nickel plus 0.00012" of zinc as a Corronized coating was equivalent to 0.0022" of galvanized coating.

Mullin⁹⁰ discussed the *application of electroplating to aircraft manufacture* including deposits of copper, tin, cadmium, chromium, silver, lead and indium, including the cycles of operation and the solutions used at the Wright Aeronautical Corp. The *effects of impurities* of various kinds on the operation of copper, nickel, cadmium and zinc solutions were reported by Meyer⁹¹. The theories underlying the various phenomena met with in electroplating were interpreted by Blum, Beckman & Meyer⁹² who discussed the physical and chemical qualifications of deposits intended for certain purposes and the operation and control of most solutions.

The review of the *properties of cyanide plating solutions* presented by Thompson⁹³ was referred to above. Gray⁹⁴ showed the effect of pH variations in cyanide plating solutions on the current density ranges, using the Type E glass electrode which has a very small sodium ion error even in solutions of very high pH.

Beckwith⁹⁴ investigated the *removal of chromium contamination* from alkaline plating solutions and found that the addition of 1 oz. of sodium hydrosulfite to each 100 gallons of plating solution was sufficient to reduce the hexavalent chromium to trivalent chromium, the latter having no effect

on the cathode. As a possible reaction the author suggested:



ALLOY COATINGS

THE underlying principles of alloy plating, were discussed by Faust⁹⁵ with special attention to anodes, addition agents, functions of the common variables and of the bath constituents. A report on brass plating which included the effects of variables on the percentages of zinc in the deposit and the operation and control of brass solutions for ornamental plating and for rubber adherence was presented by Coats⁹⁶. This same subject was also covered by Young⁹⁷ who included the so-called bronze solutions and in addition fully discussed the effect of ammonia on the operation of the bath.

New alloy solutions introduced during the past year were ethylene diamine solutions for copper-lead alloys which gave bright, solid and adherent but brittle deposits on rotating cathodes, according to the investigators Roszkowski, Hanley, Schrenk and Clayton⁹⁸. Also introduced was a patented solution for the production of a tarnish resistant silver alloy, deposited from a solution containing silver fluoride, stannic fluoride, tartaric acid, dextrose, boric acid and uranium hydroxide according to the claim⁹⁹.

A bath containing caustic soda, cyanide and salts of zinc, cadmium and mercury was patented by Roberts¹⁰⁰, the deposits of the ternary alloy being claimed to have a protective character when deposited for 10 minutes at about 10-25 amp./sq. ft.

CADMIUM-COBALT-INDIUM-IRON-LEAD-RHODIUM

AS PART of the Electrochemical Soc. Symposium on Electrodeposition, papers on iron, cobalt and cadmium plating were presented by Thomas¹⁰⁰, Soderberg, Pinner & Baker¹⁰¹ and Soderberg & Westbrook¹⁰² respectively. Although containing little new, these papers are important because of their complete summarization of former and present practice in the deposition of these metals.

Weisberg¹⁰³ reported the results of his experimental work on phosphate type rhodium plating solutions, especially on the one containing 0.2% rhodium and 5% free phosphoric acid. His experiments showed that the cathode efficiency increases with decrease in free acid, with increased rhodium content, with increased temperature and with decreased current density.

Linford¹⁰⁴ presented his data on the indium sulfate solution which he found to be very stable and constant in performance within the pH range of 2.0 to 2.7, this being controlled by the use of a combination of soluble and insoluble anodes. The solution consisted of 21 g. of indium, 15.5 cc. of sulfuric acid and 10 g. of sodium sulfate per liter, operated at room temperature, with a current density of 20 amp./sq. ft., indium anodes and 2.0-2.5 volts.

Hammond, Adolphson and Young¹⁰⁵

patented a method of building up worn shafts by iron plating in a solution of ferrous sulfate and ferrous ammonium sulfate at a pH of between 6.0 and 6.4, a temperature of above 150° F. and a current density of about 80 amp./sq. ft., using ammonia gas to maintain the pH within the specified limits.

A patent was granted to Sullivan¹⁰⁶ on an immersion lead solution consisting of a lead salt, alkali and cyanide giving as an example a solution containing 1.5 g. of lead monoxide, 100 g. of caustic soda, 50 g. of sodium cyanide and 0.05 g. of a wetting agent per liter, at room temperature.

CHROMIUM

AS WOULD be expected in these times, "hard" chromium plating was the subject of most studies on chromium plating. The loss of strength in steels due to hydrogen absorption during hard chromium plating was studied by Schmidt & Gebauer¹⁰⁷. Steels of various analyses in the form of rods 0.4" in diameter by 4.5" long were plated for 2 hours at 50 amp./sq. dm. and 130° F. and were then submitted to a bend test to determine the loss of strength. As a result of these studies the authors claimed that the general opinion prevailing in chromium plating shops that carbon steels are better for plating than alloy steels is not valid, since the former showed greater loss of strength than the latter, due to hydrogen absorption. Heating to 400° F. after chromium plating, or to 350° F. if that was the tempering range, was found to increase the strength. Two steels were practically unaffected by hydrogen, one containing 0.4% carbon, 1% silicon, 1% chromium and 2% tungsten and the other containing 0.6% carbon, 0.7% silicon, 1.6% chromium and 2.5% tungsten. These alloys are good for complicated parts and dies tending to form cracks during plating. "Hot work" die steels and two alloy carburizing steels, one containing 3.5% nickel and 0.75% chromium and the other containing 1.2% chromium and 0.25% molybdenum, were also only slightly affected by hydrogen.

McGregor¹⁰⁸ suggested a solution of 3 lb. of chromic acid plus 0.4 oz. of sulfuric acid per gallon of water at 80° F. and 250 amp./sq. ft. for 20 min., the deposit from which he claimed to triple the life of molds used for pyrex glass at a temperature of about 2800° F. Beerwald¹⁰⁹ suggested a solution of 320 g. of chromic acid and sulfuric acid to the amount of 1.2% of the chromic acid for chromium plating on aluminum. He deposited 0.0007" in one hour at 50 amp./sq. dm. and 120° F., the deposit withstanding bending. The author stated that hydrofluoric acid baths are not satisfactory for hard chromium deposits on aluminum unless the current density is extremely high. Before plating, the aluminum articles were cleaned, pickled in nitric acid and dipped in a saturated solution of nickel chloride containing 2% hydrofluoric acid and 4% boric acid. For aluminum-magnesium alloys, he found that a solution containing 15% copper chloride and 0.5% hydrochloric acid was better, the dipping time increasing from 30 sec. for a 9% magnesium

alloy to 1.5 minutes for pure aluminum.

Murray¹¹⁰ patented a solution for plating the backs of zinc printing plates containing 1.5 lb. of chromic acid, 12 oz. of glycerine, 2 oz. of phenol, 3 oz. of ammonium persulfate and one gallon of water at 140° F. and 390 amperes, preceded by a dip in chloracetic acid solution.

A comparison between the 33 oz. and the 53 oz. solutions was made by Mankowich¹¹¹ who also discussed the thickness of deposit required for various purposes. The author stated that the hardness of the basis metal need not be more than Rockwell C-20 to C-30, and stressed the importance of anodic chromic acid cleaning prior to plating, recommending a solution containing 29.0 oz./gal. of chromic acid and 0.26 oz./gal. of sulfuric acid at 6 volts, 115-120° F. for 1-2 min. (It may be noted here that this solution differs from the one reported to be used at Pratt-Whitney a few years ago in that it contains sulfate and would probably be covered by the patent held by Metals Protection Corp.)

A history of chromium plating and a description of present practice was contained in a paper by Dubpernell¹¹² which also contained a very complete set of electrodeposition tables for chromium.

COPPER

THE history of acid copper plating and electroforming and present practice was the subject of a paper by Winkler¹¹³ while Dowd¹¹⁴ described the procedures followed in copper plating rotogravure plates, stereotypes and electrotypes.

Newton & Furman¹¹⁵ offered an explanation for the paradoxical behavior of copper in ammoniacal solutions, namely that increase in the copper concentration and increase in agitation lowers the cathode efficiency. An important factor, according to the authors is the ratio of cuprous to cupric ions.

The subject of copper plating from the rochelle salt-cyanide solution was reviewed by Graham & Read¹¹⁶. Maher¹¹⁷ varied the pH in this type of solution, keeping all other conditions constant, and found that peeling of the deposits on die castings was experienced when the pH was in the normal operating range of 12.2 to 12.6, which will come as somewhat of a surprise to many platers who have been operating under these identical conditions for years, following with a nickel and chromium deposit.

Very timely, in view of the shortage of rochelle salts, was the publication of a paper by Smith & Munton¹¹⁸ on the use of citrates instead of rochelle salts as an addition to cyanide copper plating solutions. The pH was raised to 12.6 with potassium hydroxide instead of sodium hydroxide to supply potassium ions which had been found to increase the cathode efficiency independently of the citrate. The cathode efficiency of the citrate solution containing potassium ions was found to be about 7.5% less than that of a rochelle copper solution while the anode efficiency was about 18.3% lower at 50 amp./sq.ft. However, the character of the deposit was better from the

citrate bath, showing greater luster and less tendency to burn.

A description of the operating conditions and the equipment required for the Uni-chrome pyrophosphate copper solution was given by Coyle¹¹⁹. This solution was patented by Stareck¹²⁰ who gave as an example a bath containing 200 g. of copper sulfate, 200 g. sodium pyrophosphate and 30 g. sodium chloride per liter, operated at pH 8.3 using the glass electrode for control, and at a temperature of 95° F., using a current density of 10 amp./sq.ft. at 0.8 volt, small amounts of metallic compounds and anions being added for brightening.

A patent was issued to Holt¹²¹ on a cyanide copper solution containing a betaine to prevent pitting. A typical solution contained 17 oz. of sodium cyanide, 16 oz. of copper cyanide, 4 oz. of caustic soda, 2 oz. of sodium thiocyanate and 1-20 cc. of a 25% water solution of trimethyl-C-cetyl alpha betaine per gallon, to be employed at 75-80° C. and 15-45 amp./sq.ft.

GOLD

KUSHNER continued his monthly articles on various phases of gold plating, in one of which he covered heavy gold deposits¹²². He pointed out that due to the fact that plated gold of a given carat color is higher in gold content and consequently thinner than a rolled gold of the same carat color, its wear resistance is lower. In another issue he discussed the age hardening of gold alloys and the various metals which are suitable as basis metals for gold plating¹²³. In connection with the rapid deposition of gold for heavy deposits, a gold solution was suggested¹²⁴, prepared according to a recommended procedure and containing 2 oz. of potassium gold cyanide, 2 oz. of potassium cyanide, 2 oz. of potassium carbonate and 1.5 oz. of boric acid dissolved in 1/2 gal. of water. To this was added a solution of nickel cyanide in potassium cyanide solution and the whole diluted to one gallon. It was claimed that this solution could be used at 20 amp./sq.ft. in a still tank, and up to 100-200 amp./sq.ft. with agitation.

Kushner was also granted a patent¹²⁵ on a method of gold plating ferrous alloys directly using a solution containing cyanide, carbonate, gold and ammonium benzoate and sodium formate to suppress ionization of the gold.

NICKEL

THE history and development of the art of nickel plating was presented by Pinner, Soderberg & Baker¹²⁶. Tucker¹²⁷ followed the development of nickel plating solutions from the original solution of Boettger in 1842 to Wesley's straight chloride solution of 1940. Following fast on the heels of Wesley's work came the shortage of nickel chloride and it became the task of Diggin¹²⁸ to inform the plating industry how it could use the Watts type of solution without adding nickel chloride. Among the possibilities mentioned were the use of magnesium chloride, which does not have any deleterious effects below a concentration of 3.0 oz./gal., additions of hydrochloric acid to lower the pH instead of sulfuric acid and

production of nickel chloride from nickel anodes and hydrochloric acid using the porous pot method.

In addition to the problem of replenishing the chloride content of Watts nickel solutions, the shortage of nickel anodes introduced the further problem of operating with insoluble anodes in those solutions already containing chloride, with the corrosive action of the chlorine liberated at the anodes to be contended with. Hogaboom, Jr.¹²⁹ presented a number of materials which might be suitable for this purpose and also discussed the control of the pH which would, of course, go down quickly when using insoluble anodes.

Dowd's procedures for plating rotogravure plates, stereotypes and electrotypes¹³⁴ have been referred to above. In connection with the deposition of nickel on brass, Dudley¹³⁰ pointed out that a continuous coating of nickel ensures immunity from season-cracking of brass under conditions which without it would quickly produce failure. Frasch¹³¹ patented a process of nickel plating aluminum by first cleaning cathodically in an alkaline cleaner containing cyanide and zinc or other metal electropositive to nickel and electronegative to aluminum, followed by nickel plating in a solution containing a polyaminonickel sulfate, ammonium acetate and magnesium sulfate.

The brightening effects of a large number of organic addition agents of the phenyl related compounds in the Watts type nickel solutions were reported by Linick¹³² and the effects of additions of inorganic colloids such as metallic sols, etc., on nickel deposits were studied by Puri & Juneja¹³³ and Puri and Mahmood Alvi¹³⁴ on copper and on iron respectively. They found that silver and gold sols gave the best deposits, hard and lustrous with the least pitting. Prussian blue sol also gave a hard, bright deposit but with more pitting than silver or gold sols.

Waite & Martin¹³⁵ patented an anti-pitting agent comprising a sulfuric ester of a normal primary aliphatic alcohol having from 8 to 18 carbon atoms or an alkali metal salt of a sulfate of the higher alcohols such as lauric, myristic, cetyl and stearic, giving sodium lauryl sulfate as an example.

Patents on nickel brighteners were granted to Freed¹³⁶ who claimed a mixture of salts containing about 7.25 parts of cobalt to 1 part of cadmium, zinc, mercury or mixtures of these, and to Lind, Harshaw & Long¹³⁷ who claimed aromatic amino compounds and other materials such as aromatic sulfonates, sulfonamides, etc., the first acting as the brightener and the second acting to remove the hardness of the deposits.

The effects of organic and inorganic impurities which may cause trouble in nickel plating were described by Diggin who¹³⁸ pointed out the concentration of impurities in solutions by evaporation of water therefrom. The author stated, for example, in a 400 gal. air agitated solution operated at 160° F., as much as 20 gal. of water are required in an eight hour day. Among the impurities discussed in detail were iron, aluminum, calcium, magnesium, alkali metals, carbonates, oxygen, pH and organic and suspended matter.

SILVER

THE practice of silver plating was presented by Promisel and Wood¹³⁹ before the Electrochemical Society as a contribution to the symposium on electrodeposition. This was one of the very few papers ever published on silver plating from the cyanide solution to compare the potassium and sodium cyanide baths with experimental data to support the conclusions, and may be considered an important reference work on the subject.

Gilbertson & Mathers¹⁴⁰ investigated the deposition from baths containing amines. They found that the hydrocyanides of guanidine, triethanolamine and ethylene diamine can be used to take the place of sodium and potassium cyanide. The organic amines of higher molecular weight did not appear to be as suitable for this purpose as those of low molecular weight. The baths do not seem to have any commercial application at present because of the great cost of the materials.

Savage & Pfefferle¹⁴¹ described the semi-bright silver plating installation at C. G. Conn, Ltd., for finishing musical instruments. The bath contained 2.0-2.25 oz. of silver, 2.3-3.0 oz. of free sodium cyanide and 16 oz. of potassium nitrate per gallon and was operated at 86-95° F. and a current density of 5-20 amp./sq.ft. The silver strike also contained 16 oz./gal. of potassium nitrate and for soft soldered joints was preceded by a one minute strike in a rochelle copper followed by a 3.5 minute nickel plate in a Watts type solution containing 4 oz./gal. of magnesium sulfate. The nickel chloride-hydrochloric acid strike was also found satisfactory as a pretreatment for soldered joints before silver striking but because of its poor throwing power was not considered as good on this type of work as the copper and nickel deposits.

The comparative costs, salability, usefulness, design and manufacture of silver plated articles to replace articles formerly plated with nickel and chromium were discussed by Bregman¹⁴² who believed that during the present emergency silver plating would make a satisfactory substitute and would conserve strategic materials.

TIN

ELECTRODEPOSITION of tin from the acid solution and from the stannate solution was covered by Pine¹⁴³, and Oplinger and Bauch¹⁴⁴ respectively as part of the Electrochemical Society's symposium. Baier¹⁴⁵ also discussed the operation, maintenance and analysis of stannate plating solutions.

Homer & Watkins¹⁴⁶ studied the soldering of electrotinned articles and found that the thickness of the deposit is the dominant factor. They recommended minimum thicknesses of 0.0002" on brass, 0.00015" on copper and 0.0001" on steel if they are to be stored less than 6 weeks before soldering while approximately double this is recommended for storage up to two years.

A general procedure for obtaining bright electrotin deposits on steel, according to Lutz¹⁴⁷, is to immerse the dry, plated article in three mineral oil baths in se-

quence. The first is kept at a temperature below the tin fusion point, the second above it and the third is cooled to a temperature where no immediate transition occurs. Usually vegetable oils are added to the fusion bath for brightness and the author suggested a process which was claimed to eliminate the vegetable oil, consisting of immersion for 2-5 seconds at 200° F., before dipping in the three mineral oil baths, in a solution containing 50-100 g. of citric acid, 20-30 g. of stannous chloride and 20-30 g. of hydrazine hydrochloride or guanidine hydrochloride per liter at a pH of approximately 1.

The brightening of electrotinned strip was also the subject of a patent granted to Nachtman¹⁴⁸ covering a process requiring subjection of the plated strip to a medium maintained at a temperature sufficiently high to alloy the tin with the basis metal.

American practice in hot-tinning of copper sheets, tubes, pipe and wire was discussed by Imhoff¹⁴⁹. The same author described methods of recovering tin from the slag and dross, using heat and specially designed furnaces¹⁵⁰. Hot tinning was the subject of two papers by Homer, who presented a complete review of the process for steel and iron¹⁵¹ and the hot tinning of fabricated articles, both ferrous and non-ferrous¹⁵², paying special attention to the operating conditions for each step in the process. All the important data available to June 1940 were listed for the hot-tinning of cast iron in an article in *The Iron Age*.¹⁵³

Three patents were granted for the recovery of tin by detinning processes. Gregory¹⁵⁴ claimed the deposition of the tin from an alkaline detinning solution, after adding sodium chloride to precipitate the soluble soaps formed during detinning. Robinson¹⁵⁵ claimed deposition from a hydrochloric acid solution containing from half to all of the tin in the stannic form, together with iron substantially entirely in the ferrous form and using graphite anodes at room temperature. A similar process was claimed by Ogden & Heberlein¹⁵⁶ in which the chlorine formed during electrolysis was removed from the solution.

ZINC

A STUDY of the peculiarities of zinc electrodeposits by Fischer & Barmann¹⁵⁷ showed that the rate of corrosion in hydrochloric acid and in sodium chloride depended on the amount of electrolysis of the solution. If the solutions were electrolyzed sufficiently, there was very little difference between the deposits from different types of zinc plating solutions. Zinc coatings showed a protective action on aluminum. Brightness of bright zinc was attributed to a preferred crystal orientation rather than fine grain size. Alkaline deposits were found to be less ductile and less porous than acid deposits and the base steel was subject to much more hydrogen embrittlement.

A summary of cyanide zinc plating practice was presented by Hull & Wernlund¹⁵⁸. Westbrook¹⁵⁹ was granted a patent on a brightener for cyanide zinc baths consisting of an oxyheterocyclic compound such as furoates and morpholines and a metal such

as molybdenum. Ferm¹⁶⁰ received a patent on the reduction of the anode efficiency in cyanide zinc plating to correspond with that of the cathode by the addition of small amounts of magnesium to the molten zinc prior to casting into anodes.

Lyons¹⁶¹ presented a discussion of acid zinc plating in which he reviewed the literature but offered nothing new in the way of plating processes or procedures. The effects of impurities both in the insoluble lead anodes and in the solution used for acid zinc plating with such anodes were investigated by Koenig, MacEwan and Larsen¹⁶² who found that the lead content of the deposited zinc was due chiefly to occluded lead peroxide and the only materials which inhibited the formation of lead peroxide were cobalt as sulfate in the solution and silver alloyed with the lead as anode. The degree of anodic polarization was found to be a function of the logarithm of the current density. It was indicated that the ratio between the surface of a silver-lead alloy anode and one of pure lead could be determined from the difference in anodic polarization of these electrodes. Bray and Morral¹⁶³ suggested, for zinc sulfate solutions containing up to 3.6 g./l. of chloride, a quaternary alloy anode containing 3.5% thallium, 0.05% calcium, 0.03% tellurium and the balance lead. This alloy was found to be more insoluble than other alloys in the presence of chloride.

A patent was granted to Tainton¹⁶⁴ on a coarsely crystalline zinc coating having a high degree of ductility and produced at high speed in a solution containing zinc sulfate with high concentrations of free sulfuric acid such as 20-30% plus the addition of small amounts of inorganic colloids such as silica and alumina. Ductile deposits were also claimed by Bray and Morral¹⁶⁵ from a solution of zinc sulfate and sulfuric acid containing small amounts of an unsubstituted amine such as trimethylamine.

The repair of areas of galvanized sheets which had been damaged during fabrication, by application of amalgams of mercury and zinc¹⁶⁶, mercury and tin¹⁶⁷ and mercury, lead and tin¹⁶⁸ were claimed in patents granted to Kohler.

On the subject of hot galvanizing, Burnett¹⁶⁹ pointed out the possible increase in pot life and the decrease in loss of zinc as dross resulting from uniform application of heat to the pot by the use of a molten lead jacket. Imhoff also discussed ways of saving zinc¹⁷⁰ and the composition of drosses and the methods of increasing their iron content¹⁷¹. Investigation of the character of drosses at different temperatures showed that increase in bath temperature results in a greater quantity of dross, higher iron content of the dross and greater specific gravity of dross. The crystal form of dross was found to change above 900° F.

Plating Non-Conductors and Electroforming

A NUMBER of articles on the methods used for producing conducting films on non-conducting surfaces and deposition of metal thereon were published during the past

year, all covering the same procedures and presenting nothing new. Among these were articles by Bregman¹⁷², Kushner¹⁷³, Wein¹⁷⁴ who also discussed the formation of copper films by reduction, in addition to the usual silver films, and Beaver¹⁷⁵ who also discussed the burnishing of the electrodeposits using plastic burnishing media of about the same specific gravity as the plated materials, a deposit also having been formed on the burnishing material.

A discussion of silvering methods and the results of an investigation of the measurement of thickness of the film were offered by Hepburn¹⁷⁶. Light refraction rings were used as a measure of the film thicknesses which ran from 0.000001" to 0.000006".

A method of improving the adherence of metallizing powder to wax comprising the incorporation of about 0.1% by weight of a fatty acid such as stearic or oleic acid in the powder was patented by Hunter¹⁷⁷. Laux¹⁷⁸ minimized the lifting of the reduction film on non-conductors during the subsequent copper plating, by first depositing a thin film of copper in a solution of 40-100 g./l. of copper sulfate and 2.5 g./l. of sulfuric acid on the reduced metal film.

Electroforming of molds was the subject of two patents, one to Bishop¹⁷⁹ on a method of forming tire molds by deposition on a rubber model, and the other to Dunn¹⁸⁰ on a method of producing a plurality of molds on one plate. Ewing¹⁸¹ patented a method of producing electroformed hollow radiator bodies, using a fusible core of the desired shape. Norris¹⁸² was granted four patents on the production of electroformed screen on etched and filled matrices of various designs. Kuhlman¹⁸³ received a patent on a process of electroforming reticulated sheets and Sherman¹⁸⁴ received one on the production of electroformed stencils, using a casein paint on a wax coated base as the matrix.

Metal Coloring

PRODUCTION of colors and patterns from the copper lactate bath was discussed by Stareck¹⁸⁵ who mentioned the properties of the deposits and the throwing power of the bath.

A method of treating metal surfaces with phosphates, oxalates and oxidizing materials, followed by coloring with tris azo dyes was patented by Darsey, Thompson & Goodspeed¹⁸⁶.

A process of coloring anodized films on aluminum and its alloys was the subject of a patent granted to Graenacher & Matter¹⁸⁷ using a water soluble acyl derivative of a sparingly soluble dyestuff treated in a specified manner.

Batcheller¹⁸⁸ was granted a patent on a method of coloring stainless steel by subjection to a solution of sulfuric acid and water containing an etching inhibitor such as chromate or dichromate. A gold color could also be produced in a solution of sulfuric acid and water containing ammonium metavanadate.

Aluminum was claimed to be colored black, according to Jauch¹⁸⁹ by treating first with a hot solution of aluminum chloride, then with an acid permanganate solu-

tion and finally with an alkaline chromate solution.

Magnesium could be colored by subjecting at elevated temperatures and pressures to alkaline solution containing dyes, according to a patent issued to DeLong¹⁸⁹.

Testing and Control

METHODS for measuring surface tension were reviewed by Young & Roszkowski¹⁹² who compared the results by each method on different types of solution. The results with the stalagmometer were stated to be generally high. The other methods were consistent if proper precautions were taken.

Analyses of samples of single nickel salts by Hogaboom, Jr.¹⁹⁵ indicated that this salt is predominantly $\text{NiSO}_4 \cdot 6\text{H}_2\text{O}$ rather than the commonly accepted $\text{NiSO}_4 \cdot 7\text{H}_2\text{O}$ and therefore in calculations requiring additions of single nickel salts, a metal content of 22% would be more accurate than 20.9%.

A simple and inexpensive method of reducing ferric ions for subsequent titration with standard oxidizing agent was offered by Skolnik & McNabb¹⁹⁴. The analysis of gold in gold plating solutions and in gold deposits was reviewed by Kushner¹⁹⁵. A direct determination of both free cyanide and metallic silver in cyanide silver plating solutions by titration with silver nitrate to precipitate all the cyanide as silver cyanide, using either diphenylcarbazone as an indicator or electrometrically was developed by Read & Read¹⁹⁶. The procedure is not satisfactory for strike solutions which have a small metal content and a large cyanide content, and obviously if metallic contamination is present, the metal analysis will give high figures.

Sanz¹⁹⁷ presented a very promising method of controlling chromic acid anodizing solutions by electrometric titration with standard normal sodium hydroxide to pH 3.2 and 4.8, the amounts required being converted to free chromic acid, total chromic acid and aluminum.

The procedures and etchants used in the examination of tin and tin plate were discussed by Romig & Rowland¹⁹⁸. To bring out the alloy layer between the hot dipped tin coatings and the iron base they suggested acidified glycerine as an etchant for the tin-alloy interface, and 5% picral solution for the alloy-iron interface.

A method for measuring the thickness of a paint film or any non-conducting coating on a metal base, in which a needle is forced through the coating with a micrometer screw, was described by Wheeler¹⁹⁹. The sensitivity of the electrical contact was improved by the use of a vacuum tube amplifier and a relay actuating a small electric light switch.

Two new methods of measuring the thickness of silver coatings were presented during the year. A jet test solution consisting of 250 g./l. of potassium iodide and 7.44 g./l. of iodine was offered by Hammond²⁰⁰, a deposit of 0.0001" requiring 5.6 seconds at 25° C. Woods²⁰¹ determined the thickness of deposit on silverplated teaspoons by x-ray absorption methods in which a single

radiograph is made of both the specimen and a standard silver step tablet. A comparison of the densities of the negative of the specimen with that of the step tablet indicates the thickness.

Hall²⁰² prepared charts for determining the surface area of sheet metal stampings made of copper, brass and steel, for the use of which the only requirements are a knowledge of the thickness of the sheet in inches or the B. & S. gauge and the weight of the piece in grams or ounces. Graphs for the determination of the surface area of various kinds of screws, nuts, and threaded surfaces were also prepared by Field²⁰³.

Young & Roszkowski²⁰⁴ prepared a series of nomographs for plating to specification, including a very useful and compact one for the determination of plating time for various metals, thickness, current densities and efficiencies. The American Society for Testing Materials with the cooperation of the American Electroplaters' Society issued a newly revised specification for nickel and chromium deposits on steel²⁰⁵, and new specifications for nickel and chromium deposits on copper alloys²⁰⁶ and on zinc alloys²⁰⁷, all three being tentative.

A new method for determining porosity of zinc deposits on iron was presented in a paper by Fischer & Barmann, already referred to above¹⁵⁷. This involves cathodic treatment of the zinc coated article in an alkaline solution, followed by the determination of the bend resistance. The decrease in the bend resistance due to hydrogen embrittlement during cathodic treatment is a function of the porosity. The advantages and disadvantages of the salt spray test were discussed by Hirsch²⁰⁸ from an electroplating point of view. Lack of standardization was emphasized.

A clarification and evaluation of corrosion testing practice was made by Rohrman²⁰⁹ who discussed the variables encountered, the physical nature to be considered, the operation of the corrosion test and the interpretation of the results. A potential measuring method for testing the corrosion resistance of painted iron was based by Gibney²¹⁰ on the fact that a corroding metal becomes more electronegative with time, using a calomel reference electrode and a recording potentiometer. This test determined how well a paint would protect metal surfaces.

Patents issued during the year included an apparatus for electrochemical analysis granted to Matheson, Nichols, Robinson and Du Chene²¹¹, a glass membrane type of pH electrode to Cary & Baxter²¹², and a surface contour testing machine to Poupitch²¹³.

Miscellaneous

THE technical developments and the patent literature of the year 1940 were presented by Hall & Hogaboom²¹⁴. Simonds²¹⁵ linked the specification and application of finishing methods to the basic, functional, overall engineering design of the complete product. He pointed out that the character of the service to be encountered will determine the finish, which must then improve purchaser acceptance and user satisfaction.

The uses of of laminated phenolic type plastics for rack coatings, plating cylinders, tank linings, etc., were discussed by Ben-

nett²¹⁶. The advantages and disadvantages of rubber lined equipment were pointed out by McHugh²¹⁷ who also advised as to the care of rubber lined plating tanks. The problems which the plating industry has presented to the rubber manufacturer and the solutions which have made rubber the commonly used material it now is were mentioned by True²¹⁸.

The various types of automatic plating machines were described by Shaffer²¹⁹, including the straight line conveyor, the return type, the elevator type, the side arm type, the angle type and the small parts machine. Rectifiers, as a source of direct current for the electroplating industry were discussed by Lee^{220, 221}, Bregman²²², Berry²²³, Smith²²⁴, and Reinken²²⁵. Berry and Smith debated the superiority of motor-generator sets as against rectifiers with the former taking the first and the latter taking the second. Reinken pointed out one of the most important advantages of the rectifier, namely the flexibility which permits coupling of units in various ways to get different outputs in voltage and current.

Organic finishing was the subject of a number of articles. Wetlauffer & Scott²²⁶ described a goniphotometer for comparing the gloss of organic coatings. Butler produced a method²²⁷ of determining the film density of a paint with a high degree of accuracy as a step in the determining of paint mileage. Baldwin²²⁸ discussed the fundamentals of spray gun use and the education of operators with sketches showing the different types of spray patterns. Faulhauber²²⁹ discussed the technique of grain-ing for finishing filing cabinets and allied steel office units. Kendall and Massey²³⁰ determined the factors involved and the mechanism of the breakdown of organic films in water. Their results showed that for maximum water stability a film must have small water hydrolysis, low solubility, permeability and absorption. The conditions for the efficient use of radiant heat baking, the advantages, disadvantages and the finishes which can be used were pointed out by Klinkenstein²³¹. The removal of baked coatings by immersion in a water emulsion of a phenol or cresol and potassium oleate until the coating is loosened was patented by Buckman²³².

Removal of impurities from plating solutions was the subject of papers by Meyer²³³ who discussed the source of impurities, the critical concentrations and the methods of elimination from various plating solutions and by Stocker²³⁴ who gave the chemical and electrochemical methods for their removal.

The proper operation of filters for the removal of impurities was covered in all its phases by Helbig²³⁵ who included the use of filter media such as filter aids and activated carbon. Weisberg²³⁶ listed the characteristics and uses of activated carbon, stating that the carbon treatment was satisfactory often in low pH solutions while the Liscomb or ferrous sulfate method was limited to solutions having a pH above 5 and recommending a bent cathode for testing the completeness of the treatment. A few case histories were given. A complicating factor in the use of carbon and other adsorption materials may be the

patent granted to Korpiun²⁰⁷ covering the purification of plating baths by bringing them into contact with inert solid adsorption materials of large specific surface capable of adsorbing gases such as activated charcoal.

Accepting the principle that a given minimum air velocity is required at the center of the electrolyte surface for effective fume control on tanks of all widths, Battista, Hatch and Greenburg²³⁸ as the result of tests, found indications that the rate of ventilation should vary approximately with the 0.6 power of the tank width rather than directly with the width. Uniformity of ventilation was obtained by attention to the proper design of the exhausting manifold.

Two methods for the disposal of waste liquors from chromium plating were suggested by Hoover & Masselli²³⁹. One used scrap steel to reduce the chromic acid to trivalent chromium with lime as a neutralizer and precipitating agent. Barium sulfide could be used as a combined reducing and precipitating agent with lime for the completion of neutralization and precipitation. The most feasible recovery process appeared to involve the use of sulfur dioxide as a reducing agent and soda ash as a precipitant. The precipitate is filtered and roasted to produce chromic trioxide in saleable form.

Treatment of plating room waste water at the plant of the Electrolux Corp. to remove impurities and to put the water in suitable condition for discharge into the sewage system or into Long Island Sound was described by Hodges²⁴⁰. To remove metals and color and bring the pH to above 7 for discharge into the sewers, the solution is first brought down to pH 3 or lower, and barium sulfide is added to reduce chromic acid to trivalent chromium. When the solution has a green color, a hydrated lime slurry is added to bring the pH to 6 or above, at which point the metals precipitate and form a heavy floc which is filtered out while the supernatant clear liquid is discharged.

The control of enameling temperatures was effected, according to Barrows²⁴¹ by focussing a radiation pyrometer on the work and setting an alarm at the predetermined temperature to indicate time for removal of the fired ware from the furnace.

Metal spraying technique was described by Benner²⁴² for the use of the Schori powdered zinc gun used to coat structural shapes. In another article on this subject the technique, tools, and methods for spraying with stainless steel were described²⁴³.

Among the miscellaneous patents issued during the year were a method for the removal of copper deposits from iron by reverse current in a solution containing about 15% ammonium nitrate by weight and 10% ammonia by volume, issued to Day²⁴⁴, a method for increasing the efficiency of the detinning process for tin plate comprising the addition to the caustic stripping solution of a small amount of a cobalt oxide, an alkali metal aluminate, dextrine and starch, which was claimed by Mandl²⁴⁵, and an anode holder for stubs which allows all the scrap anode to be consumed, issued to Veale²⁴⁶.

Bibliography

- H. J. Read & A. K. Graham. Trans. Electrochem. Soc., **88**, prep. 5 (1941).
- A. Brenner. Proc. Amer. Electropl. Soc., **28-34** (1941).
- A. E. Lorch. Trans. Electrochem. Soc., **79**, prep. 14 (1941).
- A. Hickling & F. W. Salt. Trans. Faraday Soc., **37**, 319-21 (1941); **37**, 333-9 (1941).
- M. R. Thompson. Trans. Electrochem. Soc., **79**, prep. 7 (1941).
- A. V. Engel. Nature, **146**, 66 (1940).
- D. S. Hartshorn, Jr. Metal Finishing, **39**, 123-30 (1941).
- W. G. Imhoff. Prod. Finishing, **5**, 50-2, 54-6, 58-60 (Aug. 1941); **5**, 56-8, 60-9 (July 1941).
- G. B. Hogaboom. Proc. Amer. Electropl. Soc., **62-4** (1941).
- W. J. Conley. Proc. Amer. Electropl. Soc., **129-42** (1941).
- A. E. Hostetter, W. A. Van Winkle & H. H. King. Metal Finishing, **39**, 310-14 (1941).
- J. D. Edwards & F. Keller. Trans. Electrochem. Soc., **79**, prep. 11 (1941).
- E. R. Holman. Metal Finishing, **39**, 132-4 (1941).
- P. P. Mozley. Metal Finishing, **39**, 301-5 (1941).
- M. Schenk. U. S. Pat. No. 2,262,967 (Nov. 18, 1941).
- M. Schenk. U. S. Pat. No. 2,260,278 (Oct. 21, 1941).
- M. Schenk. U. S. Pat. No. 2,231,373 (Feb. 11, 1941).
- R. W. Buzzard. U. S. Pat. No. 2,261,960 (Nov. 11, 1941).
- A. Muller & J. Korpiun. U. S. Pat. No. 2,231,086 (Feb. 11, 1941).
- J. Korpiun. U. S. Pat. No. 2,233,785 (Mar. 4, 1941).
- R. I. Wray. Metal Finishing, **39**, 642-7 (1941).
- R. W. Buzzard. U. S. Pat. No. 2,248,062 (July 8, 1941).
- R. W. Buzzard. U. S. Pat. No. 2,248,063 (July 8, 1941).
- H. K. DeLong & J. B. Reid. U. S. Pat. No. 2,228,259 (Jan. 14, 1941).
- A. Beck, G. Siebel & E. Nachtigall. U. S. Pat. No. 2,229,236 (Jan. 21, 1941).
- J. M. Michel & F. Henneberger. U. S. Pat. No. 2,229,253 (Jan. 21, 1941).
- J. S. Thompson. U. S. Pat. No. 2,234,206 (Mar. 11, 1941).
- Tin and Its Uses, 12-14 (May 1941).
- V. M. Darsey. Ind. & Eng. Chem., **33**, 222-4 (1941).
- E. E. Halls. Steel, **106**, 60-2 (Jan. 13, 1941).
- H. R. Neilson. U. S. Pat. No. 2,227,945 (Jan. 7, 1941).
- J. B. Castner. U. S. Pat. No. 2,243,853 (June 3, 1941).
- R. W. Shoemaker. U. S. Pat. No. 2,257,133 (Sept. 30, 1941).
- G. Becker & F. Steinberg. U. S. Pat. No. 2,257,668 (Sept. 30, 1941).
- G. C. Romig. U. S. Pat. No. 2,245,609 (June 17, 1941).
- H. J. Lodecien. U. S. Pat. No. 2,233,422 (Mar. 4, 1941).
- J. S. Thomson & E. S. Hanson. U. S. Pat. No. 2,250,508 (July 29, 1941).
- V. Nelson & A. C. Herro. U. S. Pat. No. 2,245,561 (June 17, 1941).
- C. J. MacKav. U. S. Pat. No. 2,244,526 (June 3, 1941).
- J. S. Thomson & E. W. Goodspeed. U. S. Pat. No. 2,227,469 (Jan. 7, 1941).
- C. L. Faust & H. A. Prav. Proc. Amer. Electropl. Soc., **104-12** (1941).
- H. H. Uhlig. Proc. Amer. Electropl. Soc., **20-24** (1941).
- G. F. Meyer, G. D. Rahrer & J. R. Viella. Metals & Alloys, **13**, 424-30 (1941).
- G. A. Lux. Proc. Amer. Electropl. Soc., **54-61** (1941).
- G. B. Hogaboom, Jr. Metal Finishing, **39**, 673 (1941).
- E. B. Galtsher. Steel, **106**, 74-6, 109 (Nov. 3, 1941).
- J. F. Siefen. Iron Age, **147**, 46-9 (May 1, 1941).
- L. W. MacFarland & S. Krugloff. U. S. Pat. No. 2,226,624-5 (Dec. 31, 1940).
- C. J. Peterson & A. H. Peterson. U. S. Pat. No. 2,239,140 (Mar. 25, 1941); U. S. Pat. No. 2,251,690 (Aug. 5, 1941).
- H. J. Barton & R. H. Barton. U. S. Pat. No. 2,239,140 (Apr. 22, 1941).
- P. E. Hawkinson. U. S. Pat. No. 2,240,559 (May 6, 1941).
- F. H. Thompson. U. S. Pat. No. 2,244,582 (June 3, 1941).
- F. E. Hendrickson. U. S. Pat. No. 2,260,941 (Oct. 28, 1941).
- W. S. Thomas. U. S. Pat. No. 2,263,410 (Nov. 18, 1941).
- R. V. Twynning. U. S. Pat. No. 2,246,554 (June 24, 1941).
- R. W. Mitchell. Machinery, **47**, No. 12, 111-12 (1941); **48**, No. 1, 117-19 (1941); **48**, No. 2, 133-4 (1941); **48**, No. 3, 117-19 (1941); **48**, No. 4, 133-4 (1941); **48**, No. 5, 199-200 (1941).
- M. Zinty. Iron Age, **148**, 38-41, 79 (Oct. 16, 1941); 31-35 (Oct. 23, 1941).
- N. Promisel. Prod. Finishing, **5**, 48-57 (Feb. 1941).
- E. H. Lyons, Jr. Trans. Electrochem. Soc., **80**, prep. 12 (1941); Proc. Amer. Electropl. Soc., **118-22** (1941).
- J. F. J. Thomas. Canadian J. Research, **19B**, 109 (1941).
- H. J. Noble. Iron Age, **148**, 45-52 (Nov. 27, 1941).
- J. P. Abrahams. U. S. Pat. No. 2,228,026 (Jan. 7, 1941).
- G. H. Orozco. U. S. Pat. No. 2,254,492 (Sept. 2, 1941).
- E. A. Matteson & K. B. Bowman. U. S. Pat. No. 2,259,260 (Oct. 14, 1941).
- C. F. Reed. U. S. Pat. No. 2,239,974 (Apr. 29, 1941).
- J. G. Vail. U. S. Pat. No. 2,243,054 (May 20, 1941).
- F. J. Curtis. U. S. Pat. No. 2,257,545 (Sept. 30, 1941).
- P. A. Salz. U. S. Pat. No. 2,245,052 (June 10, 1941).
- H. L. Beaver. Prod. Finishing, **5**, 30-4 (Jan. 1941).
- H. L. Beaver. Prod. Finishing, **5**, 58-63 (Feb. 1941).
- H. L. Beaver. Prod. Finishing, **5**, 60-5 (Mar. 1941).
- H. L. Beaver. Prod. Finishing, **5**, 44-6, 50, 52 (Apr. 1941).
- H. L. Beaver. Prod. Finishing, **5**, 38-40, 42, 46, 47 (Aug. 1941).
- H. L. Beaver. Prod. Finishing, **5**, 36-8, 40, 42, 43, 46 (Sept. 1941).
- H. L. Beaver. Prod. Finishing, **6**, 90-5 (Oct. 1941); **6**, 28-9, 32, 34, 36 (Nov. 1941).
- C. A. Zapffe & C. E. Sims. Metals & Alloys, **13**, 737-42 (1941).
- G. H. Damon. Ind. & Eng. Chem., **33**, 67-9 (1941).
- D. S. Hartshorn, Jr. Metal Finishing, **39**, 561-3 (1941).
- E. C. Britton & F. N. Alquist. U. S. Pat. No. 2,227,804 (Jan. 7, 1941).
- J. N. Ostrofsky. U. S. Pat. No. 2,261,744 (Nov. 4, 1941).
- D. C. Hilly. U. S. Pat. No. 2,249,383 (July 15, 1941).
- R. R. Kalischer. U. S. Pat. No. 2,253,334 (Aug. 19, 1941).
- C. Johnson. U. S. Pat. No. 2,250,379 (July 22, 1941).
- W. M. Humphrey & R. E. Lee. U. S. Pat. No. 2,257,960 (Oct. 7, 1941).
- F. C. Abbott. U. S. Pat. No. 2,258,310 (Oct. 7, 1941).
- D. R. Clarkson. U. S. Pat. No. 2,255,445 (Sept. 9, 1941).
- W. Blum. Chem. & Met. Eng., **48**, 78-9 (Aug. 1941).
- F. E. P. Griggs. Monthly Rev. A.E.S., **23**, 92-100 (1941).
- R. Rimbach. Metal Finishing, **39**, 360-4 (1941).
- U. A. Mullin. Monthly Rev. A.E.S., **23**, 185-95 (1941).
- W. R. Meyer. Metal Finishing, **39**, 369-72 (1941).
- W. Blum, A. O. Beckman & W. R. Meyer. Trans. Electrochem. Soc., **80**, prep. 33 (1941).
- A. G. Gray. Proc. Amer. Electropl. Soc., **36-47** (1941).
- M. M. Beckwith. Proc. Amer. Electropl. Soc., **80-83** (1941).
- C. L. Faust. Trans. Electrochem. Soc., **80**, prep. 18 (1941).
- H. P. Coats. Trans. Electrochem. Soc., **80**, prep. 37 (1941).
- C. B. Young. Iron Age, **147**, 60-5, 104 (Feb. 13, 1941).
- E. S. Roszkowski, H. R. Hanley, W. T. Schrenk & C. Y. Clayton. Trans. Electrochem. Soc., **80**, prep. 34 (1941).
- L. B. Davis & R. H. Galbreath. U. S. Pat. No. 2,259,270 (Oct. 14, 1941).
- C. T. Thomas. Trans. Electrochem. Soc., **80**, prep. 15 (1941).

101. G. Soderberg, W. L. Pinner & E. M. Baker. Trans. Electrochem. Soc., **80**, prep. 32 (1941).
102. G. Soderberg & L. R. Westbrook. Trans. Electrochem. Soc., **80**, prep. 27 (1941).
103. M. Weisberg. Metal Finishing, **39**, 16-22 (1941).
104. H. B. Linford. Trans. Electrochem. Soc., **79**, 187-94 (1941).
105. W. H. Hammon, E. I. Adolphson & W. Y. Young. U. S. Pat. No. 2,229,077 (Jan. 21, 1941).
106. J. D. Sullivan. U. S. Pat. No. 2,230,602 (Feb. 4, 1941).
107. M. Schmidt & K. Gebauer. Techn. Zentralbl. prakt. Metallbearbeitung, **50**, 466, 525-6 (1940).
108. D. McGregor. American Machinist, **85**, 854-5 (1941).
109. A. Beerwald. Aluminium, **23**, 149-55 (Mar. 1941).
110. J. J. Murray. U. S. Pat. No. 2,234,189 (Mar. 11, 1941).
111. A. Mankowich. Metal Finishing, **39**, 294-6 (1941).
112. G. Dubpernell. Trans. Electrochem. Soc., **80**, prep. 24 (1941).
113. J. H. Winkler. Trans. Electrochem. Soc., **80**, prep. 28 (1941).
114. J. E. Dowd. Proc. Amer. Electropl. Soc., 52-4 (1941).
115. R. C. Newton & N. H. Furman. Trans. Electrochem. Soc., **80**, prep. 19 (1941).
116. A. K. Graham & H. J. Read. Trans. Electrochem. Soc., **80**, prep. 10 (1941).
117. M. F. Maher, Jr. Proc. Amer. Electropl. Soc., 128-9 (1941).
118. C. W. Smith & C. B. Munton. Metal Finishing, **39**, 415-21 (1941).
119. T. G. Coyle. Proc. Amer. Electropl. Soc., 113-6 (1941).
120. J. E. Stareck. U. S. Pat. No. 2,250,556 (July 29, 1941).
121. D. S. Holt. U. S. Pat. No. 2,255,057 (Sept. 9, 1941).
122. J. B. Kushner. Prod. Finishing, **5**, 20-8 (Jan. 1941).
123. J. B. Kushner. Prod. Finishing, **5**, 24-6, 28, 30-1, 34, 36, 38, 40 (Mar. 1941).
124. J. B. Kushner. Prod. Finishing, **5**, 72-4, 76, 78-80, 82, 84 (June 1941).
125. J. B. Kushner. U. S. Pat. No. 2,227,454 (Jan. 7, 1941).
126. W. L. Pinner, G. Soderberg & E. M. Baker. Trans. Electrochem. Soc., **80**, prep. 23 (1941).
127. W. M. Tucker. Monthly Review, A.E.S., **28**, 881-8 (1941).
128. M. B. Diggin. Monthly Review, A.E.S., **28**, 793-4 (1941).
129. G. B. Hogaboom, Jr. Metal Finishing, **39**, 315 (1941).
130. J. D. Jevons. Modern Industrial Press, **3**, 40 (Nov. 1941).
131. J. Frasch. U. S. Pat. No. 2,233,410 (Mar. 4, 1941).
132. L. L. Linick. Metal Finishing, **39**, 611-14 (1941).
133. V. S. Puri & G. C. Juneja. J. Indian Chem. Soc., **17**, 58, 699 (1941).
134. V. S. Puri & F. R. Mahmood Alvi. J. Indian Chem. Soc., **17**, 58, 699 (1941).
135. V. H. Waite & B. P. Martin. U. S. Pat. No. 2,254,161 (Aug. 26, 1941).
136. M. L. Freed. U. S. Pat. No. 2,228,991 (Jan. 14, 1941).
137. R. Lind, W. J. Harshaw & K. E. Long. U. S. Pat. No. 2,238,861 (Apr. 15, 1941).
138. M. B. Diggin. Metal Finishing, **39**, 13-15 (1941).
139. N. E. Promisel & D. Wood. Trans. Electrochem. Soc., **80**, prep. 35 (1941).
140. L. I. Gilbertson & F. C. Mathers. Trans. Electrochem. Soc., **80**, prep. 13 (1941).
141. F. K. Savage & P. R. Pfefferle. Monthly Rev. A.E.S., **28**, 101-9 (1941).
142. A. Bregman. Iron Age, **148**, 59-62 (Nov. 13, 1941); 52-55 (Nov. 20, 1941).
143. P. R. Pine. Trans. Electrochem. Soc., **80**, prep. 31 (1941).
144. F. F. Oplinger & F. Bauch. Trans. Electrochem. Soc., **80**, prep. 25 (1941).
145. S. Baier. Steel, **109**, 66-9, 86 (Oct. 27, 1941).
146. C. E. Homer & H. C. Watkins. Metal Industry (London) Jan. 3, 1941.
147. G. A. Lutz. Metal Finishing, **39**, 131 (1941).
148. J. S. Nachtman. U. S. Pat. No. 2,240,265 (Apr. 29, 1941).
149. W. G. Imhoff. Metal Finishing, **39**, 188-91 (1941).
150. W. G. Imhoff. Metal Finishing, **39**, 607-10 (1941).
151. C. E. Homer. Iron & Steel, **14**, 230-3, 239, 266-8, 363-5 (1941).
152. C. E. Homer. Tin Res. Inst. Pub. No. 102 (1940).
153. Iron Age, **147**, 55-8 (Apr. 24, 1941).
154. W. C. Gregory. U. S. Pat. No. 2,229,073 (Jan. 21, 1941).
155. R. T. Robinson. U. S. Pat. No. 2,250,843 (July 29, 1941).
156. D. L. Ogden & M. F. Heberlein. U. S. Pat. No. 2,253,865 (Aug. 26, 1941).
157. H. Fischer & H. Barmann. Zeit. fur Metallkunde, **32**, 376 (1940).
158. R. O. Hull & C. J. Wernlund. Trans. Electrochem. Soc., **80**, prep. 36 (1941).
159. L. R. Westbrook. U. S. Pat. No. 2,233,500 (Mar. 4, 1941).
160. E. W. Ferm. U. S. Pat. No. 2,243,696 (May 27, 1941).
161. E. H. Lyons, Jr. Trans. Electrochem. Soc., **80**, prep. 16 (1941).
162. A. E. Koenig, J. U. MacEwan & E. C. Larsen. Trans. Electrochem. Soc., **79**, prep. 8 (1941).
163. J. L. Bray & F. R. Morral. Trans. Electrochem. Soc., **80**, prep. 17 (1941).
164. U. C. Tainton. U. S. Pat. No. 2,231,967 (Feb. 18, 1941).
165. J. L. Bray & F. R. Morral. U. S. Pat. No. 2,245,086 (June 10, 1941).
166. H. L. Kohler. U. S. Pat. No. 2,255,780 (Sept. 16, 1941).
167. H. L. Kohler. U. S. Pat. No. 2,255,978 (Sept. 16, 1941).
168. H. L. Kohler. U. S. Pat. No. 2,255,979 (Sept. 16, 1941).
169. A. S. Burnett. Steel, **108**, 48-50 (Jan. 27, 1941).
170. W. G. Imhoff. Steel, **108**, 56-7, 86 (Mar. 24, 1941).
171. W. G. Imhoff. Products Finishing, **5**, 24-6, 28, 30, 32, 34, 36 (May 1941).
172. A. Bregman. Iron Age, **147**, 50-4 (June 12, 1941); 46-9 (June 19, 1941).
173. J. B. Kushner. Prod. Finishing, **6**, 96-8, 100-5 (Oct. 1941).
174. S. Wein. Metal Finishing, **39**, 666-72 (1941).
175. H. L. Beaver. Products Finishing, **5**, 62-4, 6, 8, 9 (June 1941); 30-2, 4, 6 (July 1941).
176. J. R. Hepburn. J. Electrodep. Tech. Soc., **17**, 1-10 (1941).
177. J. H. Hunter. U. S. Pat. No. 2,240,300 (Apr. 29, 1941).
178. R. Laux. U. S. Pat. No. 2,243,429 (May 27, 1941).
179. J. W. Bishop. U. S. Pat. No. 2,243,521 (May 27, 1941).
180. A. C. Dunn. U. S. Pat. No. 2,258,579 (Oct. 7, 1941).
181. H. O. Ewing. U. S. Pat. No. 2,260,893 (Oct. 28, 1941).
182. T. C. Kuhlman. U. S. Pat. No. 2,230,868 (Feb. 4, 1941).
183. W. R. Sherman. U. S. Pat. No. 2,255,440 (Sept. 9, 1941).
184. J. E. Stareck. Proc. American Electropl. Soc., 48-51 (1941).
185. V. M. Darsey, J. S. Thompson & E. W. Goodspeed. U. S. Pat. No. 2,236,549 (Apr. 1, 1941).
186. C. Graenacher & M. Matter. U. S. Pat. No. 2,237,483 (Apr. 8, 1941).
187. C. Batcheller. U. S. Pat. No. 2,243,787 (May 27, 1941).
188. O. Jauch. U. S. Pat. No. 2,247,580 (July 1, 1941).
189. H. K. DeLong. U. S. Pat. No. 2,250,472 (July 29, 1941); 2,250,473 (July 29, 1941).
190. S. T. Roberts. U. S. Pat. No. 2,250,842 (July 29, 1941).
191. E. O. Norris. U. S. Pat. No. 2,231,678 (Feb. 11, 1941); 2,246,380 (June 17, 1941); 2,250,435 (July 22, 1941); 2,250,436 (July 22, 1941).
192. C. B. Young & E. S. Roszkowski. Metal Finishing, **39**, 193-6, 243-6, 306-9, 314 (1941).
193. G. B. Hogaboom, Jr. Metal Finishing, 674 (1941).
194. H. Skolnik & W. M. McNabb. Metal Finishing, 241-2 (1941).
195. J. B. Kushner. Products Finishing, **5**, 38-40, 42, 44, 46-7, 50, 52, 54 (July 1941).
196. H. J. Read & C. P. Read. Metal Finishing, **39**, 612-4 (1941).
197. M. Sanz. Monthly Rev., A.E.S., **28**, 709-17 (1941).
198. O. E. Romig & D. H. Rowland. Met. & Alloys, **13**, 436-43 (1941).
199. R. E. Wheeler. Prod. Finishing, **5**, 54-6, 58 (Apr. 1941).
200. R. A. Hammond. J. Electrodep. Tech. Soc., **16**, 69-82 (1940).
201. R. C. Woods. Metal Finishing, **39**, 365-8 (1941).
202. N. Hall. Metal Finishing, **39**, 662-5 (1941).
203. G. C. Field. Metal Finishing, **39**, 483-5 (1941).
204. C. B. Young & E. Roszkowski. Prod. Finishing, **5**, 42-4, 46-7, 51-9 (Mar. 1941).
205. A. S. T. M. Desig: A166-41T (1941).
206. A. S. T. M. Desig: B141-41T (1941).
207. A. S. T. M. Desig: B142-41T (1941).
208. A. Hirsch. Proc. Amer. Electropl. Soc., 11-14 (1941).
209. R. A. Rohman. Monthly Rev., A.E.S., **28**, 27-34 (1941).
210. R. B. Gibney. Bell Laboratories Record (Oct. 1941).
211. L. A. Matheson, N. B. Nichols, H. A. Robinson & C. F. Du Chene. U. S. Pat. No. 2,246,981 (June 24, 1941).
212. H. H. Cary & W. P. Baxter. U. S. Pat. No. 2,256,733 (Sept. 23, 1941).
213. O. J. Poupitch. U. S. Pat. No. 2,261,093 (Oct. 28, 1941).
214. N. Hall & G. B. Hogaboom, Jr. Metal Finishing, **39**, 2-8, 10 (1941).
215. H. R. Simonds. Elec. Mfg., **27**, 52-4, 84, 86 (Mar. 1941).
216. F. I. Bennett. Metal Finishing, **39**, 238-40 (1941).
217. C. P. McHugh. Proc. Amer. Electropl. Soc., 16-20 (1941).
218. O. S. True. Monthly Rev., A.E.S., **28**, 354-60 (1941).
219. R. W. Shaffer. Metal Finishing, **39**, 72-5, 83 (1941).
220. I. A. Lee. Proc. Amer. Electropl. Soc., 122-8 (1941).
221. I. A. Lee. Products Finishing, **6**, 68-71, 74, 76-82 (Oct. 1941).
222. A. Bregman. Iron Age, **148**, 48-53 (Sept. 11, 1941); 43-47 (Sept. 25, 1941).
223. G. J. Berry. Monthly Review, A.E.S., **28**, 259-65 (1941).
224. I. R. Smith. Monthly Rev., A.E.S., **28**, 265-70 (1941).
225. L. W. Reinken. Metal Finishing, **39**, 66-9 (1941).
226. L. A. Wetlauffer & W. E. Scott. Metal Finishing, **39**, 224-8 (1941).
227. F. Butler. Metal Finishing, **39**, 167-8 (1941).
228. W. P. Baldwin. Metal Finishing, **39**, 229-32 (1941).
229. F. V. Faulhaber. Metal Finishing, **39**, 54-6 (1941).
230. J. T. Kendall & L. Massey. Trans. Faraday Soc., **37**, 232-44 (1941).
231. G. Klinkenstein. Proc. Amer. Electropl. Soc., **39**, 93-9 (1941).
232. J. F. Buckman. U. S. Pat. No. 2,242,106 (May 13, 1941).
233. W. R. Meyer. Proc. Amer. Electropl. Soc., 65-8 (1941).
234. O. A. Stocker. Proc. Amer. Electropl. Soc., 76-80 (1941).
235. W. A. Helbig. Proc. Amer. Electropl. Soc. 68-76 (1941).
236. L. Weisberg. Metal Finishing, **39**, 297-300 (1941).
237. J. Korpium. U. S. Pat. No. 2,248,092 (July 8, 1941).
238. W. P. Battista, T. Hatch & L. Greenburg. Heating, Piping & Air Conditioning, **13**, No. 2, (1941).
239. C. R. Hoover & J. W. Masselli. Ind. & Eng. Chem., **33**, 131-4 (1941).
240. M. E. Hodges. Metal Finishing, **39**, 70-71, 83 (1941).
241. W. A. Barrows. Prod. Finishing, **6**, 18-20, 22, 24, 26 (Nov. 1941).
242. C. F. Benner. Iron Age, **148**, 56-9 (July 17, 1941).
243. Iron Age, **147**, 46-50 (Feb. 6, 1941).
244. W. E. Dav, Jr. U. S. Pat. No. 2,241,585 (May 13, 1941).
245. M. Mandl. U. S. Pat. No. 2,243,165 (May 27, 1941).
246. G. W. Veale. U. S. Pat. No. 2,256,820 (Sept. 23, 1941).

A REVIEW OF HOT-DIP GALVANIZING AND HOT-DIP TINNING ACTIVITIES DURING THE YEAR 1941

THE past year has been marked by two outstanding things in both the fields of hot-dip galvanizing and hot-dip tinning, namely, extreme activity, and shortage of metals. Both industries have been confronted with the vital questions of how to get enough metal to operate, and how to conserve, and use to the best advantage the metal they have available, and can get. Confronted with the two extremes of a heavy demand for their products, and difficulty in getting the raw materials to produce them, this has been the most vital thing of interest to all hot-dip galvanizers and hot-dip tanners during the past year.

Driven almost to desperation to obtain enough metals and materials to operate these two industries have set into motion every facility for the bettering of operating conditions, and the improvement in galvanizing technique. As might be expected, since galvanizer's dross contains about 96% of good zinc as an average figure, this by-product has been attacked with the greatest interest for many years. Old hand-methods of cutting and slicing the dross were good enough when zinc was plentiful and easy to get, but now it is most vital to get every pound of good zinc out of the dross and leave only the dry zinc-iron alloy crystals. A saving of 10 to 15% of good zinc can be made in most plants by using a dross vibrator, and in some plants the saving of metal has reached as high as 20% over the amount that could be obtained by old hand methods of cutting and slicing the dross. A very large number of galvanizing plants have taken advantage of this piece of equipment as a new supply of zinc formerly sold at dross prices.

The same interest in conservation of metal has been shown by hot-dip tanners, but since most of these plants outside of the tin plate industry are not on such a large scale as galvanizing plants, their methods of conserving their metal has been largely one of a study of the recovery of the metallics in the by-products, and improving their operating practice and conditions. Methods of metal recovery which just were not of any interest at all when metal was plentiful, are now studied carefully, and put into operation in many plants.

The matter of priorities has also affected and placed great limitations on both hot-dip galvanizers and hot-dip tanners. Many inquiries by those not knowing the details or fully appreciating the technical knowledge

By Wallace G. Imhoff

President of the Wallace G. Imhoff Co.
Vineland, New Jersey

and

Technical Director of Research,
American Hot-Dip Galvanizers Association,
Inc.,

903 American Bank Building,
Pittsburgh, Pa.

and practical experience required, have come from people who want to "jump" into both the hot-dip galvanizing and hot-dip tinning business now that times are good again, and there is much business available. A word of caution is sent out to these people, since it takes perhaps six to eight months to get materials and equipment, even with priority orders. Unless the product is actually for defense, no consideration at all will be given the inquiry. Even then there is little hope of obtaining experienced practical operators since none are available, and to use unskilled labor in these fields is only inviting disaster.

As might be expected, many new things have appeared in the past year to save materials, and also to use to better advantage those available. Such activity has been of much interest in the new methods of welding galvanized iron that have been developed by the Research Department of The Artkraft Sign Co., Lima, Ohio, and covered by patent No. 2,224,953. This process is known as the "Galv-Weld" process, and is sponsored by Galv-Weld, Inc., Dayton, Ohio. The process consists in its barest essentials of rubbing over the bare spots, which have been heated by the welding, a stick of low melting galvanizing material to form thereon a smooth coating of metal which will have all of the corrosion resisting properties, as well as the wearing qualities of the original galvanized coating. The patent covers the use of any material whether bar, powder, or liquid, but to date it has been found that a bar is the most practical for structural work. Drums and other types of work require varying technique.

Other patents of interest are U. S. Patent 2,255,445, D. R. Clarkson, assignor to Ella Gorder, September 9, 1941. A method of treating ferrous sulphate from waste pickle

liquor to obtain ferric oxide and sulphuric acid by high temperature decomposition and oxidation of the liberated sulphur dioxide.

Still other patents of interest are U. S. Patent 2,215,961 granted to Edgar A. Hawk (a) W. J. Bullock, Inc., for a method of recovery of zinc from dross. Also on a protecting coating, U. S. Patent 2,255,978, H. L. Kohler, assignor to A. A. Kramer, September 16, 1941. This is a method of repairing a rupture in the zinc coating of a galvanized metallic sheet, comprising the spreading of a soft, creamy, putty-like amalgam of mercury and tin containing from 45% to 75% mercury by weight over the surface of said sheet at and adjacent to said rupture, rubbing the resultant amalgam over said rupture, removing all the excess amalgam and permitting the resultant amalgamation, over the entire area over which the same was spread, to proceed undisturbed throughout the thickness of said zinc coating over said area having the spangled appearance of the galvanized coating on said sheet, is produced.

Also patent No. 2,258,327, on coating sheet steel, also granted to A. A. Kramer October 7, 1941. This is a steel sheet having a corrosion protection coating comprising an inner ferrous-zinc alloy zone adjacent to the steel base, an intermediate zone of substantially pure zinc and an outer flexible zinc alloy zone containing a relatively small quantity of a non-ferrous metal having a lower melting point than zinc such as tin and lead.

The past year has also seen further concentrated study on the steel base as affecting galvanizing. The work done by Dr. Robert W. Sandelin, Metallurgist of The Atlantic Steel Co., Atlanta, Ga., has been outstanding. The results have been published in the official technical paper *Wire and Wire Products* of the Wire Association, January 1941, and October 1941. The original paper was presented at the Metal Congress in Philadelphia, October 22, 1941.

Both hot-dip galvanizers and hot-dip tanners using fuel oil to heat their pots will be very much interested in a small piece of equipment called a "Gasifier" presented at the Metal Congress in Philadelphia by The American Gasifier Company, Wallingford, Connecticut. The equipment actually changes oil fuel into a gas fuel, and there are none of the disadvantages of clogging up burners. Gasification of the oil is accom-

(Concluded on page 17)

A New Finishing Material for Decorative and Functional Design



Prof. J. F. McGregory (left) of Colgate University and Dr. Wm. S. Murray (right), Pres. Indium Corp. of America, examining the first gram of indium produced in 1924, and the first bar of indium metal produced in 1927.

Indium and Indium Plating

By M. T. LUDWICK

*Assistant to the President,
The Indium Corporation of America*

Introduction

FROM an historical standpoint, the metals that are indispensable to industry are of two classes—those that have been known and used since ancient times and others with a relatively short industrial history. The present critical shortage of many metals has caused sufficient research to be done on the second group of metals to indicate the breadth of their possible application to industrial uses, and to make them available at a cost to encourage their widespread adoption.

It is particularly appropriate to bring up the subject of indium at this time. Indium is a typical example of that second class of metals, as it is one of those metals that is coming into its own as a result of extensive work that has been done to lessen the demand for those metals so important to our war effort, and of particular interest to the metal finishing industry.

The author presents the fascinating story of a relatively new metal available for plating and alloying purposes. The unique properties of indium are discussed as well as its use in automotive and aircraft engine bearings, and as a reflecting surface. The ability to plate indium upon such active metals as cadmium and zinc offers a method of obtaining a relatively good corrosion resistant surface upon these metals which in turn can be used to protect a substrate of steel. The preparation of various alloys by diffusion is considered and the plating of indium is discussed in detail.—Ed.

While indium was discovered in 1863 by Reich and Richter during a spectrographic examination of zinc ores from a Freiberg mine, the limited quantities available, and the resulting high cost rendered the industrial development almost impossible. Indium was considered merely a laboratory curiosity. In 1924, Dr. William S. Murray, now President of The Indium

Corporation of America, in his examination of rare and lesser known metals, discovered and proved the value of indium in stabilizing non-ferrous metals. He had placed an order for a large quantity of indium to pursue his investigation of this metal, only to find that, after several months' search, only one gram was available. Dr. Murray then began an extensive search for a domestic source of this metal, which was considered by most authorities to be non-existent in commercial quantities.

The search was successful, and, today, as a result of years of extensive research and development that has been done by The Indium Corporation of America, under Dr. Murray's direction, indium is being produced in substantial quantities from domestic sources, both in electrolytic and commercial grades, and various salts of the metal are also available. This

work has developed patented processes for production and uses.

Three complete bibliographies were published in order to acquaint engineers and users with the metal: INDIUM—Ekeley and Potratz for the years 1863-1934; the author of this article published the second edition covering 1934-1940, as well as a Supplement for the year 1940. A supplement covering the published material of 1941 is now in preparation and will be ready for distribution early in 1942. Figure 1 accompanying this article shows Dr. Murray with Professor J. F. McGregory, with the original gram of indium, with which this development of indium was started, and the first bar of indium metal which was produced in this country in 1927.

Properties of Indium

Since many people are not familiar with the physical and chemical properties of this metal, we are listing herewith the physical properties of indium and discuss briefly some of the principal chemical characteristics.

Physical Properties

The physical properties of indium are as follows:

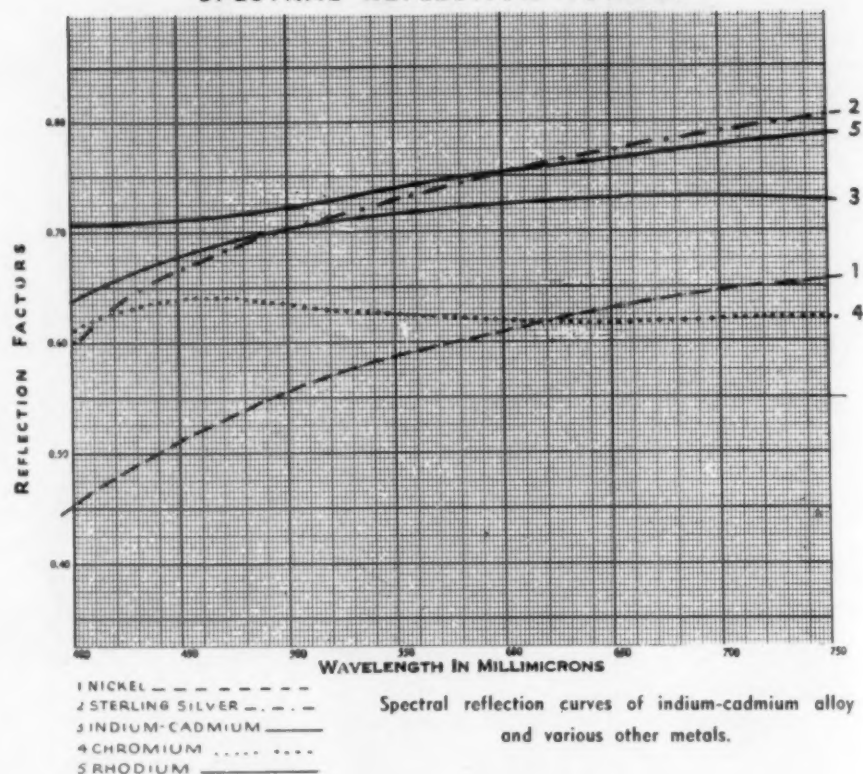
Atomic weight	114.76
Valence	Commonly 3; also 2 and 1
Melting point	155° C.
Boiling point	1450° C.
Specific gravity	7.31
Specific heat, joules/gram-atom	27.3
Electrical resistivity, ohm-cm:	
at 20° C.	9×10^{-6}
at 155° C.	29×10^{-6}
Thermal expansion, $1/L \, dl/dt$	
at 20° C.	33×10^{-6}
Hardness, Brinell No.	1

According to Wyckoff, the crystal-line structure of indium is given as face-centered tetragonal; $a_0 = 4.583 \text{ \AA}^*$, $c_0 = 4.936 \text{ \AA}^*$, four atoms per unit cell with positions 000, $0 \frac{1}{2} \frac{1}{2}$, $\frac{1}{2} 0 \frac{1}{2}$, $\frac{1}{2} \frac{1}{2} 0$. Goldschmidt reports the atomic radius of indium as being 1.569 Å.

According to Reich and Richter, the Bunsen flame is colored bluish-red by indium salts, and the flame spectrum gives two principal lines, 4511.55 and 4101.95, which lie close to the violet potassium line. The 4101.95 line, however, is observed only when a large

* = 1 Angstrom unit = 1×10^{-8} cm.—a unit of length.—Ed.

SPECTRAL REFLECTION CURVES



amount of indium is present. The spark spectrum furnishes these two lines, and, in addition, a number of other lines; the more important are 3256.22, 3039.46, 2941.39, 2890.35, 2710.39 and 2306.20.

Chemical Properties

It is impossible to give in this short discussion many of the chemical properties. Indium is silvery white, softer than lead, malleable, ductile and crystalline. At room temperature, indium is stable in dry air; on heating, it burns with a blue flame to indium trioxide (In_2O_3). Chemically, indium resembles zinc in some respects, and aluminum and iron in others; it is classified with the latter elements in the usual system of qualitative separations. It is trivalent in its stable compounds, and its sulfate forms alums with monovalent metal sulfates. Indium also acts as a bivalent element, and some monovalent compounds have been reported.

Indium Used Industrially

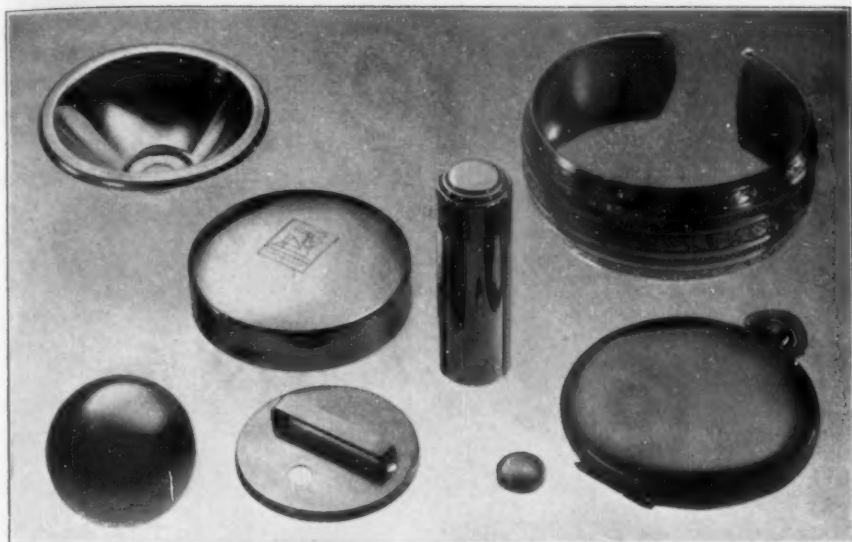
For Bearings:

Indium has found its chief industrial utility through its ability to confer increased hardness, strength and corrosion resistance, by alloying with other metals. It has had wide acceptance in the internal combustion en-

gines in aviation, automotive and diesel fields, due to its efficiency in protecting surfaces against corrosion caused by acids in lubricating oils. It has been used for some time in dental alloys and is said to impart superior compressive strength, freedom from objectionable flow under pressure and resistance to tarnish. It has been used to prevent corrosion from perspiration in hinges of spectacle frames.

For Plating:

At present, some of the most promising applications of indium appear to lie in the plating field, both for decorative and functional designs. In order for the metal finisher to thoroughly understand the value and processes of using indium, there are several important things which are necessary to relate. In the first place, indium alloy coatings are easily polished and burnished; therefore, it is not as necessary to have such a highly polished base material, unlike the extremely hard coating metals, which are difficult to polish or buff. There is a distinct advantage in not having to do as much work on the base material because, when the final polishing or burnishing is done, the relatively soft alloy coating gives a



Samples of indium plated metal including a flashlight reflector, watch case, lipstick case, bracelet and various button parts.

very good surface with high reflectivity and pleasing color. The color of indium coatings is low on the blue side of the spectrum as compared with the red side and, therefore, there is more pleasant reaction to its color. It is more like silver, which, of course, is one of the most beautiful white coatings.

It is necessary to thoroughly "de-grease" and clean the base metal so that it is free from "water-break". Those skilled in the arts of metal finishing will have no difficulty in producing this clean condition of the base metal because it is a matter of everyday routine. If the base metal is a ferrous metal, a coating of some non-ferrous metal, which will alloy readily with the indium, must first be applied to the base metal. The metal to be used will depend on the nature of the requirements for the surface to be produced. Today, there are used coatings of indium and lead; indium and copper; indium and cadmium; indium and zinc; indium and silver; and indium and gold.

The thickness of the undercoatings varies from a few ten-thousandths of an inch to one or two-thousandths, depending upon the surface requirement. For instance, where the coating is used as a bearing surface, it is not uncommon to have this coating as thick as one-thousandths or more, whereas when it is used strictly as a decorative finish, where there is little wear involved, flash deposits of the undercoating may be used in order to obtain color and luster. In the event the base

metal is not of the ferrous group, it is entirely possible to plate indium directly on the non-ferrous material.

Diffusion of Indium

After the indium coating is plated on the top of the undercoat, it is necessary to diffuse the indium into the respective surfaces. It appears that the diffusion is easier and more rapid in the softer metals which have low melting points, in contrast with those which have a higher melting point and are harder. For instance, indium will diffuse more readily into lead and tin than it will into copper or silver.

The diffusion must be started below the melting point of indium, otherwise, there is likely to be coagulation on the surface before the indium starts to diffuse into the metal. However, after the diffusion is started, the temperature may be raised above the melting point of indium, which is 155° C. (311° F.) The most popular temperature range is 175-180° C., or about 350° F. This may be accomplished in a sufficiently high flash point oil bath, or an ordinary air oven, or a controlled atmosphere oven. The time of diffusion will depend, of course, on the thickness of the coatings. From our past experience, we have been able to predict fairly readily how much time will be required for the processes, and since we have a highly trained technical staff, this experience and assistance are always available to those who are interested in indium.

Due to the shortage of some of the decorative metals, indium is able to

furnish very satisfactory coatings, similar in appearance to chromium and nickel; however, combined with those metals which are not on the critical list. For instance, a very beautiful silver-indium coating for decorative purposes is very acceptable. Due to the fact that, when indium diffuses, the diffusion is not only vertical but also horizontal, there is provided a continuous, non-porous coating, which will not chip or peel. This, of course, produces a coating which will prevent corrosion of the material over which it is coated. This is particularly true on brass and on iron and steel articles.

Indium Coatings as Reflectors

Indium alloy coatings have been studied for their value as reflecting surfaces. It is believed that these reflecting surfaces will be very permanent and free from surface disturbance. Where the reflecting surface becomes hot, it will probably be necessary to put on an undercoating to stop-off any further diffusion through the metal on which the indium was plated and diffused. Such a stop-off coating would be iron, nickel or cobalt since indium will not diffuse readily into these metals.

In the illustration which accompanies this article, it can readily be seen that, even though there is a very small amount of indium present, the type of the curve from the blue to the red is uniformly the same, and the percentage of reflectivity, as charted by the spectrophotometer, is approximately the same. While an indium coated reflector gives a lower reflectivity value than pure silver when the silver is first made, it is believed and expected that these values will stay approximately uniform, whereas that of silver will drop in a very short time.

Corrosion Resistant Alloys

There are many places where iron or steel will be used in place of metals or alloys such as nickel, silver, brass or copper. In these instances very satisfactory, non-corrosive and decorative finishes can be produced by using an undercoating of a metal, which has a higher electropotential than the iron or steel, together with the indium coating, which will give an excellent color and decorative value. A good example of this is a coating of 0.005" of cadmium, together with a small percentage of that amount of indium

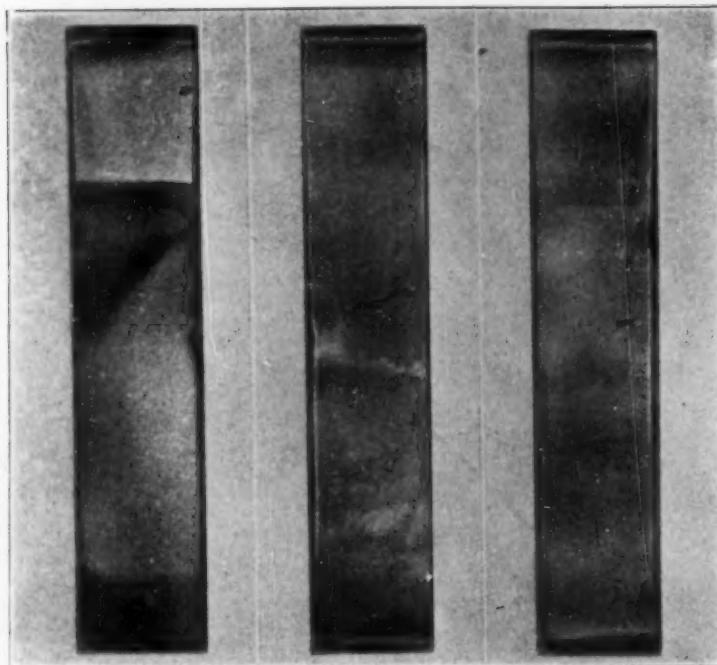


Fig. 3. Specimens of bearing alloys after corrosion tests. On the left is a cadmium-silver-copper bearing, diffused 96 hr. at 340° F. in corrosive oil; loss, 0.137 g., badly corroded. Middle bearing alloy plated with 0.017 g. indium; diffused 18 hr. at 340° F.; 144 hr. at 340° F. in corrosive oil; loss, 0.029 g., visibly corroded. Right bearing alloy plated with 0.029 g. indium; diffused 2 hr. at 340° F.; 216 hr. at 340° F. in corrosive oil; loss, 0.012 g.; no visible corrosion.

diffused into it. The color of the coating is very beautiful and has a very high reflective value. It is similar in appearance to silver, but, of course, is stable and continuous.

In addition to tests for wear, and corrosion from acids in lubricating oils, indium plated and diffused surfaces have been subjected to severe salt spray tests by various investigators. These tests have proved conclusively that indium treated surfaces will resist salt spray corrosion as satisfactorily as many of the materials which have been widely used before the present emergency. One of these tests was conducted on a steel article which was coated with lead and a 4½% coating of indium plated and diffused into the lead. We have been advised that the results were entirely satisfactory under severe operating conditions.

Special Uses for Indium

While it has been mentioned before in literature that indium may play a very important part in pharmaceuticals, we expect soon to hear of a new chemical in the field of medicine, and also a new mordant for the dyestuffs industry. Both of these products are

entirely in the experimental stage, but surprising results are indicated. Recently it has been discovered that the use of indium in brazing materials imparts to these brazing materials excellent "wetting" properties. This, of course, assists greatly by making the brazing process easier. Because of the low melting point of indium, it can be alloyed with the usual copper base brazing materials and a very wide range in melting points of brazing materials can easily be made.

Plating of Indium

Because our patented plating and diffusion process is new to many of the metal finishers, detailed information on this process is given below. This was prepared by the Technical Director of the Indium Corporation, J. R. Dyer, Jr. The material has been published elsewhere†, but due to the increased interest in the use of indium for electroplating, we believe it essential to repeat this process for the benefit of the plating industry.

Racking: The plating rack should be insulated with rubber or other suitable stop-off material to prevent waste of

† The Iron Age, Dec. 19, 1940.

metal by plating upon the rack. In addition, the portion of the work which is not to be plated should be masked with a suitable masking lacquer or other coating. Occasionally, rubber sleeves can be used for shielding purposes.

Cleaning: The cleaning procedure to be used will naturally depend upon the type of material being plated. For example, if the base coat is copper or copper plate, the procedure will be that usually employed for plating upon copper. If an active metal, such as zinc or cadmium, is to be plated, the usual precautions in cleaning and acid dipping must be observed to prevent over-etching of these metals. Pickling and cleaning, therefore, should leave a clean active surface as is required for general plating.

Plating: Plating is done from an indium cyanide-dextrose solution of the following composition:

Indium (as chloride)	4 tr. oz./gal.
Dextrose	2 oz./gal.
Sodium cyanide	12 "

Directions will be furnished by the Indium Corporation for making the indium chloride from indium metal. However, the company has for sale a stock indium chloride solution in which 1 fluid oz. of the solution contains 1 oz. InCl₃, and an 8-ounce bottle of this solution is usually used to make 1 gallon of plating solution.

Two ounces of dextrose (No. 84 Eastman or Merck's USP or equivalent quality) are dissolved in as little water as possible. Slight heating may be used to hasten solution and, if used, the solution is allowed to cool before using. Then, 12 oz. of sodium cyanide are dissolved in as little water as possible, approximately 750 cc., by means of a solution cone, and, when all the cyanide has dissolved, the dextrose solution is poured into the cyanide solution. The resulting solution is known as the sodium cyanide-dextrose solution.

The indium chloride solution is now added, in small portions, with constant stirring, to the cyanide-dextrose solution. This operation should only be carried out in a good fume-hood, or other well-ventilated place, owing to the generation of *dangerous fumes*. As the small portions of indium chloride solution are added, it will be noticed that a precipitate is formed which dissolves on stirring. Under no conditions should more chloride solution be added until this precipitate is

dissolved. However, the solution of this precipitate should take place almost immediately and no permanent precipitate should exist at this point. All the chloride solution should be added in this manner to the cyanide-dextrose solution and the resulting solution diluted to about 2 liters or $\frac{1}{2}$ gal. with distilled water. This concentrated plating solution should be allowed to stand at least 48 hr. or longer, if possible, before using to make the final bath.

After the concentrated solution has aged for 48 hr. or longer, it will be found to have turned from a straw color to dark brown. Also, a dark carbon-like precipitate will be found to have settled out. This precipitate should not be gelatinous or of considerable volume and may readily be filtered off. The solution is now filtered, by suction through a Buchner funnel for speed, using a Whatman No. 54 filter paper, into the plating tank and diluted to 1 gal. with distilled water. An analysis for free cyanide should be made at this point, and it will be found that the free cyanide will be one-third to one-half of the required bath composition, as stated above. Sufficient sodium cyanide should, therefore, be added to bring the free cyanide content of the final bath to 12 oz., or at least 100 g./l. The plating bath is now ready for use.

Operations: Insoluble anodes, such as carbon or platinum, are used and a current density sufficiently high to give gassing at the cathode is employed. The current density range is approximately from 10 to 100 amp. per sq. ft.

The throwing power of the solution is excellent and the resulting deposits are soft, gray and mat in appearance.

The rate of deposition of a new bath will be approximately 15 mg. per amp.-min., and after the bath is used or ages, the rate of deposition gradually falls off until it reaches a constant value, ranging from 5 to 8 mg. per amp.-min. Depletion of metal in the bath or of free cyanide may still lower the rate of deposition, at which time additions should be made to maintain the efficiency of the bath.

Maintenance: Since insoluble anodes are used, all metal plated is from the bath, and must be replaced by addition to the bath. Analysis of the bath and/or a record of the plating will show when these additions are necessary. If additions are necessary, they

are prepared, in the required concentrations, as in the original preparation of the bath, and are added to the bath in the concentrated solution after filtering but not diluting.

The cyanide content should not be allowed to fall below 11 oz./gal., or 90 g./l., and preferably maintained at 11 to 13 oz./gal., or 90 to 100 g./l. The indium content should not fall below 3 oz./gal. for consistent plating results.

Analysis: The method of determining the amount of free cyanide in the bath is the same as that for a silver plating bath (by means of silver nitrate), with the possible exception that the sample should be diluted to several times its volume in order that the color will not obscure the end-point.

The indium content is determined by decomposing a sample of the bath with aqua regia, precipitating the indium as hydroxide with ammonium hydroxide, filtering, washing the precipitate with ammonia water until white, the igniting of In_2O_3 over a moderate flame, and from the weight of oxide, calculating the amount of indium. A careful record of the analyses, additions and rate of deposition should be kept.

Rinsing: The plated pieces are removed from the plating bath and given several water rinses. The first rinse should be hot, and should be retained as it will contain considerable drag-out, the final rinse should be in clean hot water. The pieces are now ready for diffusion.

From the above information, it can be seen that it is easy to plate indium and to diffuse the metal into other non-ferrous materials. Almost always the first question that is asked is: "Is it necessary to have any special plating apparatus to use your process?" The answer is "no." Indium plates readily without any critical temperature or current density. Any shop which is equipped to plate silver or copper will have the apparatus necessary to go into indium plating immediately. The receptacle for the solution should either be pitch or rubber lined, or it may be lined with glass or enamel. Of course, it is essential to keep the bath free from contaminating materials or metals. The rinse water should be saved and the indium may be recovered by the operator, or the rinse water evaporated and sent to our plant for recovery of the indium.

When it is remembered that as re-

cently as 1924 several months' work was required to produce one gram of indium, it can be readily seen that its industrial history has been an extremely short one. In view of the unique properties that indium has demonstrated in this short period, it is probable that we may consider indium as being in an early stage of development even today. The uses already developed and proved will undoubtedly serve as a stimulus to further investigations of the multiple industrial uses for this amazing new commercial metal.

A Review of Hot Dip Galvanizing (Concluded from page 12)

plished by means of heat. In the past it has meant carbon deposits which very soon interfered with the operation of whatever device was used. This objection has been overcome in the Gasifier by maintaining a constant flame inside of the gasification chamber which prevents the formation of carbon deposits. The fuel and air requirements are a constant supply of No. 1 fuel oil at about 10 pounds pressure and 10 cubic feet per minute of air at 32 ounces pressure. Fuel costs are said to be reduced by about one third when using the Gasifier with fuel oil.

Hot-dip tanners have also been interested in a new protective metal coating compound marked under the name of "Amco Metallic Coating Powders, Brand 'K'," developed by the American Solder and Flux Co., Philadelphia, Pa. This material is designed for making repairs to damaged tin coatings. While the finished coating has the appearance of tin and matches perfectly the surrounding hot-dipped tin coating, it has an advantage not possessed by the original tin. Amco Brand "K" Coatings are claimed to protect the underlying iron or steel to the same extent as a hot-dipped zinc coating of the same thickness. It is due to the fact that when in contact with iron or steel in a corrosive medium, it is electropositive and therefore affords protection against rust and corrosion. The material is intended for use whenever an original tin coating has been damaged in handling, worn away through use, or burned away in a welding operation.

Constant improvement has also been made in temperature control of the metal baths in the past year. The temperatures of both the bath and that in the combustion chambers are now recorded. This gives even better control of operations, gives more protection from pot failure, and assures better operating conditions. Bulletin No. 36-4 just published by The Brown Instrument Co., Philadelphia, Pa. shows the very latest installation type of this method of temperature control.

In addition a more intensive study has been made over the past year to increase the average hot-dip galvanizing furnace efficiency. Efforts have been directed along the lines of better insulation, lower heat losses due to the products of combustion leaving the furnace too quickly, and a study of the advantages and disadvantages of the different kinds of fuels.

Du Pont Co. Opens New Laboratory

*Laboratory to be Used for Study and
Solution of Problems in Metal Treatment
and Electroplating*

The Du Pont Company has opened its new Cyanide Products Service Laboratory at the Niagara Falls, N. Y., plant of The R. & H. Chemicals Department.

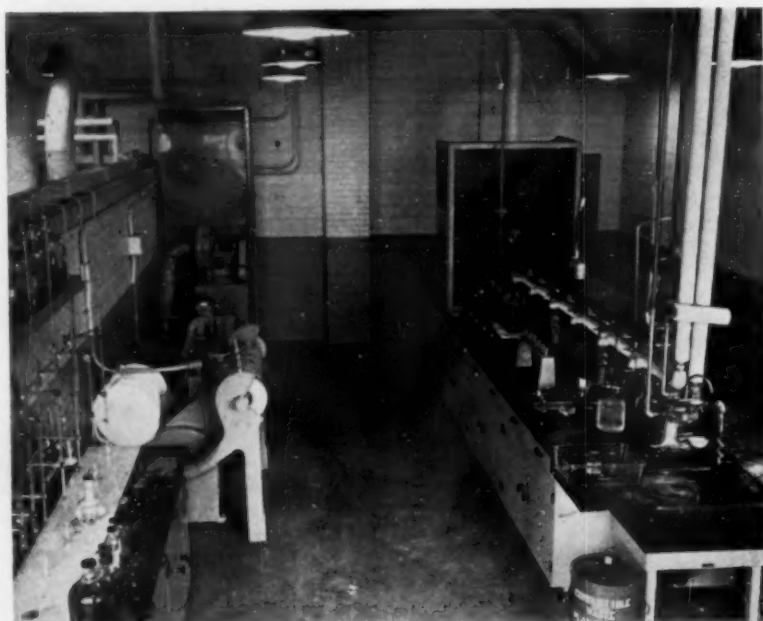
Staffed by chemists, metallurgists and technical service men, the company reports the new laboratories will be used primarily for the study and solution of customers' problems and for developments of improved metal treatment and electroplating processes.

A three-story brick building houses a cyanide products analytical and research laboratory, a metal treatment furnace room and an electroplating service laboratory. Staff offices, metallographic preparation and photographic rooms and storage space also are provided.

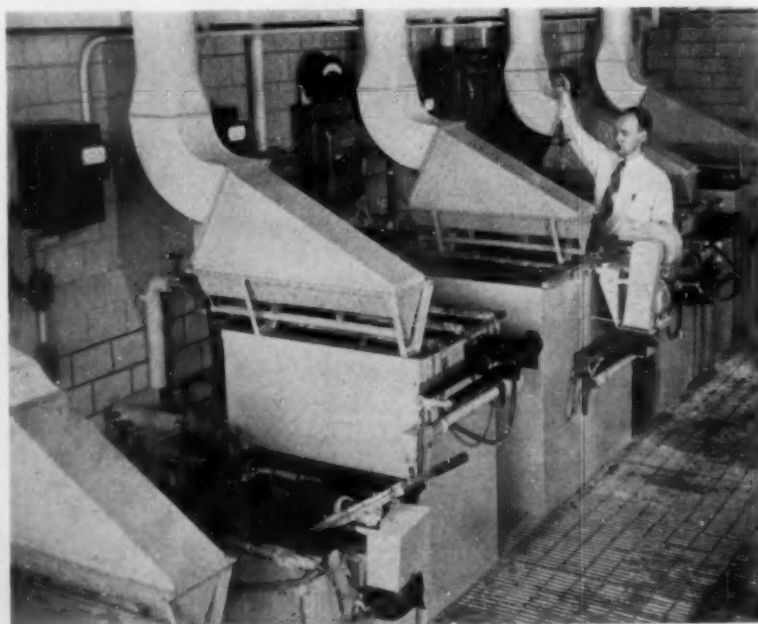
Every effort is made to duplicate plant operating conditions on a "semi-works" basis in the service laboratories. The metal treatment furnace room has electric furnaces of both the externally heated and immersed electrode types, and quench tanks and driers. The electroplating service section is complete with plating tanks, modern filtration and other electroplating equipment.

The metal treatment section has a chemical laboratory to analyze case hardening baths and heat treating compositions as well as treated metals. The metallographic preparation room has equipment for sectioning and polishing metals, and Brinell, Firth Hardometer, Rockwell, Rockwell Superficial and Scleroscope machines are used to determine the hardness of treated test pieces of metal.

Investigation of methods for removal of salts which form on sheet steel during pickling operations is one of the interesting studies continued in the new laboratory. Study of the general problems involved in metal cleaning already has resulted in industrial acceptance of a cyanide neutralizing process for cleaning steel sheets prior to vitreous enameling, bonderizing or galvanizing.



Development of simple control methods for solutions is a prime task of the electroplating analysis division. This division also runs routine analyses on electroplating solutions undergoing tests.



Examination of test samples in Du Pont's new Cyanide Products Service Laboratory. The laboratory is used for electroplating research and for technical service to the industry.

Industrial Hygiene at Work in Defense Industries[†]

BY WARREN A. COOK

Past President, American Industrial Hygiene Association, Zurich General Accident and Liability Insurance Company, Limited. Chicago, Illinois.

Introduction

INDUSTRIAL hygiene is at work in the defense industries. Modern industrial hygiene methods are accomplishing much in avoiding occupational diseases among workers and in raising the general health levels through provision of favorable occupational environment. Industrial hygiene is doing a job today for many manufacturers and large groups of workers; but by outlining the nature of these modern industrial hygiene methods, by pointing out new problems in this field which national defense activities are introducing to industry, it is our purpose to state where and how these methods can be more effectively applied in making the man-power of the country more productive.

Industry today includes many materials and many processes which may present potential health hazards. In some instances the more dangerous of those can be replaced by operations involving lesser hazards but many of them must be continued in use because they are essential to the final product. It is necessary to work out methods whereby industry can utilize the optimum material and process for a given purpose, even though they involve health hazards, in a manner which will avoid actual injury to health. By incorporating a variety of protective methods such as the industrial hygienist has at his disposal, this purpose can in practically every case be successfully accomplished.

Some Hazards Encountered

As instances of the manner in which this works out in practice, one or two examples can be presented. In a new process whereby machine threads are cut by means of silicon carbide abrasive wheels, it is necessary to use sulphur in the cutting oil for the satisfactory performance of this precision method. Certain elements in the oil cause reduction of part of the sulphur to the gas, hydrogen sulphide. When a fresh batch of this sulphuretted oil was added to the machines in one plant, a sufficient amount of hydrogen sulphide gas was liberated to cause hydrogen sulphide poisoning. *Since hydrogen sulphide is in the order of toxicity of the more familiar hydrogen cyanide,* the seriousness of the situation is at once evident. The gas which was causing the men to become sick was first identified and then a simple method was employed for avoiding further difficulty. The expedient used was to aerate the oil out in the yard immediately before adding

it to the machines, in this way causing the hydrogen sulphide gas to be liberated where it could be blown away.

In the manufacture of bullet-proof gasoline tanks for aeroplanes, benzol is used in the neoprene cements used to make up the alternate layers of leather and sponge-rubber. Benzol is also used to prepare the surfaces to be cemented. All of the benzol used evaporates into the workroom atmosphere. In one such workroom a hundred forty men were at work, forty of whom were actually using the benzol. The management became suspicious that this solvent was making the men sick. They did not wish to have a group of benzol poisoning cases on their hands and sent an urgent request for assistance in dealing with this problem, in this case to the New York State Division of Industrial Hygiene.

A survey of operating conditions by trained industrial hygienists showed that exposures to the benzol were excessive. Blood examinations indicated that nineteen of the men were sufficiently affected to require immediate transfer to operations not involving benzol. The hazard was materially reduced by substituting a less toxic solvent and, for the operations where it was preferable to continue the use of benzol due to its superior solvent properties, exhaust ventilation was designed. In fact several alternative designs were sketched and presented to the engineering staff of the concern for their consideration. The optimum ventilation system for the purpose was thus developed.

Years ago, such a situation would first have come to light through cases of disabling poisoning with probable newspaper notoriety. Such indeed was the case twenty-six years ago when three women in a group of a hundred became disabled due to benzol poisoning while cementing the fabric of dirigible gas cells. This unfortunate occurrence in a small town at the end of one of New York State's beautiful finger lakes raised a wave of hysteria which could so easily have been avoided by application of modern industrial hygiene methods.

The Modern Industrial Hygiene Method

Just what is this modern industrial hygiene method? Briefly, it includes first, a general plant survey for cataloguing processes and materials—both those used and pro-

[†] Presented before the Sixth Annual Meeting, Industrial Hygiene Foundation of America, Inc., Mellon Institute, Pittsburgh, Pennsylvania, Thursday, November 13, 1941.

duced—which may affect health. Second, tests should be made to learn whether exposure to these processes and materials are of such magnitude as to cause actual injury to health. These tests may be analyses of the air to learn whether the plant atmosphere contains excessive amounts of the injurious agent or examinations of the worker, his lungs and an x-ray of them, his blood, or his urine. Some of the operations may be obviously satisfactory or obviously damaging. In the latter case, the second step would be omitted. The third step is the actual control of the condition as required by the particular situation. The control measures may include enclosure, ventilation, general or local, wet methods, improved housekeeping, or personal protective devices.

But that is not enough. The practical plant engineer knows that equipment is improved and changed; the chemist knows that new materials are introduced and new processes developed; the maintenance man knows that equipment deteriorates, that exhaust pipes erode through at the elbows, that enclosures get bent out of shape by cranes and trucks, and that workers will knock holes in one end of a ventilating hood to improve one condition entirely unmindful of the unbalancing of the rest of the system.

Consequently the fourth step includes a constant check to assure that control of a health hazard once made does not deteriorate or change so that the health of the workers is again jeopardized. This check may also take the form of air analyses or tests on the man. It should be carried further to bring to light any new problems which may be introduced through such industrial readjustments of national defense as the manufacture of time fuses for shells in a watch factory or the introduction of vapor degreasers and chromium plating tanks incident to greater precision necessary for gears destined for bombers or pursuit planes rather than trucks or automobiles.

It is not enough merely to have a general impression that certain materials may be injurious and others not, or that some processes have been the source of publicized compensation claims and that others have escaped undesired attention. Especially in these times when both men and materials are at a premium, it is of vital importance to proceed on sure ground under the guidance of well-trained, experienced supervision.

Agencies Active in Industrial Hygiene

Industrial hygiene is meeting the added problems presented by accelerated production schedules and expanded industrial operations. The federal government has mobile units in the field which have been making a thorough study of industrial health hazards in all Ordnance Department establishments, in certain industrial plants of the Air Corps, and at the Quartermaster Corps depots. In addition some 36 government-owned contract-operated plants have been given systematic investigation. A staff of 44 professional persons trained in various phases of the industrial hygiene procedure are engaged directly in these field activities in defense industries.

The full staff of the Industrial Hygiene Division of the National Institute of Health numbers 150 persons whose resources are available to assist the state, county and

municipal industrial hygiene divisions. At the present time the staffs of these divisions total 320 workers divided among 40 such units whose budget for the present fiscal year amounts to a million dollars.

The state industrial hygiene programs are all concerned with furnishing services to privately owned and operated defense industries. Weekly bulletins are sent to the state units listing defense contracts. These plants are then investigated by these units which refer monthly reports to the States' Relations Section of the Federal Division of Industrial Hygiene for review.

As an indication of the extent of this state supervision, twenty of these industrial hygiene divisions during the two months of July and August provided services for 846 plants employing nearly half a million workers. The bulk of this work was in the airplane industry, manufacture of military vehicles, at shipyards, explosives plants, and other defense industries.

The Bureau of Medicine and Surgery of the U. S. Navy has established a section on Industrial Health to provide consultation services for all shore establishments of the Navy. At the present time there are more than 20 specially selected medical officers who have received medical training in industrial hygiene and 16 additional medical officers who are now undergoing training at Harvard and Columbia Universities.

There are also many Navy Medical Officers who have attained a high degree of proficiency in industrial medicine through personal experience and are now serving in the Medical Departments of the various shore establishments.

It is recognized that a Medical Officer doing Industrial Health work needs the help of an industrial hygiene engineer with necessary laboratory and field equipment to function effectively. To date only two qualified industrial hygienists have been obtained but the Secretary of the Navy has directed Commandants to increase their efforts to secure these specialists. Due to the scarcity of available Industrial Hygienists, it may become necessary for the Navy to authorize the enrollment of recent graduates of schools of chemical engineering, sanitary engineering, mechanical engineering and send them to an intensive course of training for a period of four months to qualify them as industrial hygienists.

Private agencies are also active. The field service of the Industrial Hygiene Foundation has been pressed to the limit in providing consultation services and making actual surveys of operating conditions at the plants of its members. A number of insurance companies have been making available to their industrial policy holders technical field and laboratory services for the study, evaluation and control of health hazards. Private consultants are available in the study of special problems. In an increasing number of industrial and mining concerns, capable men are being assigned to industrial hygiene work.

Although there is no complete catalogue of the personnel engaged in industrial hygiene as a part of private enterprise, their ranks include able men active in practical control of conditions under their immediate surveillance. The major portion of the membership of the American Industrial Hygiene Association is comprised of men with a

direct connection with industry or with private agencies. Many of the more experienced governmental industrial hygiene personnel are also members of this Association which thus permits an exchange of ideas for the promotion of practical measures for industrial health maintenance.

All industrial hygiene activity is by no means conducted by those who designate themselves as industrial hygienists. In a large foundry in the State of Iowa, it was the plant engineer who devised the ingenious arrangement for dampening used molding sand as it dropped onto the conveyor belt from the mechanical shake-out at irregular intervals. A metal flap was installed to rest lightly on the belt. As a flaskful of sand was shaken onto the belt, the flap was raised, opened a water valve to a spray nozzle directed onto the belt. This simple expedient effected a forty per cent reduction in the dust exposure of the operators of the mullers to which the sand was returned for reconditioning. Such instances of ingenious methods of control by plant engineers, superintendents and maintenance men are numerous, but the measure of the effectiveness of the method usually depends upon technical industrial hygiene methods.

New Industrial Hygiene Problems Incident to National Defense

A great many of the factors in industrial hygiene which are presented by the national defense industries are identical to those encountered in normal industrial activity. However, new developments during the past year incident to national defense have introduced new problems—some of these are merely new to a manufacturer who has changed his operations, other require special investigation to determine whether or not actual health hazards may exist.

MAGNESIUM CASTING

Illustrative of the latter situation is the rapidly expanding magnesium foundry industry. Magnesium foundry practice has been developed principally by a large concern which has a keen appreciation of the necessity of control of potential health hazards, maintains an able staff for this purpose and has potential health hazards under observation. Consequently we anticipate no appreciable injury from a number of these special hazards which this industry introduces. The advantages of giving proper attention to them before, rather than after a group of cases of injury to health have occurred, are evident.

As is well known, magnesium burns very easily. In order to control combustion when the molten metal is poured into the mold, sulphur is added both to the molding sand and to the cores and, in addition, is sprinkled on top of the molten metal in the ladle. The sulphur is oxidized to the extremely irritating gas, sulphur dioxide, which rises from the operation due to convection currents even though this gas is itself just twice as heavy as air. In foundries constructed for the purpose, general ventilation is probably sufficient to keep sulphur dioxide exposures within limits which will not cause excessive irritation to the upper respiratory tracts. However, in older foundries which may be adapted to the production of magnesium castings—and there are at least a score of foundries casting magnesium

throughout the country—it is possible that adequate provision may not be made for the removal of sulphur dioxide. Unless recognition is taken of the need for adequate ventilation, not only for the protection of the men in the area where pouring is being conducted but also for the protection of those who may be in the path of the gas as it rises to the ceiling with hot air currents, cools off and then drops due to its higher specific gravity to expose men some distance away, a chronic irritation of the throat may develop among the group of workers.

It has been shown in the refrigeration industry, where groups of men are exposed to moderately excessive amounts of sulphur dioxide, that a defensive mechanism is set up which permits this group to work in the presence of the irritating gas without going into paroxysms of coughing; but in spite of defense mechanisms, workers develop morning coughs and experience other symptoms indicative of excessive irritation and also systemic symptoms such as tendency to increased fatigue and shortness of breath on exertion. The latter symptom is one which the foundryman does not welcome since it is also a symptom of development of silicosis.

Some of the sulphur in the molding sand can be replaced with ammonium silicofluoride as an oxidation inhibiting agent. Although we know of no actual determinations to show the extent of exposure to the fluoride products which would be given off when hot metal comes in contact with such a compound, tests were made in the closely analogous aluminum foundry industry. These have shown that there may be excessive exposure to fluoride in connection with the use of the sodium silicofluoride in fluxing the molten metal in open hearth furnaces. The acrid fumes presumably are made up of hydrofluoric acid and silicon tetrafluoride, the latter reacting with water vapor in the atmosphere for the final production of fluosilicic acid, hydrofluoric acid and silicon dioxide. In such an operation it was shown that fluoride concentrations average seventeen parts per million in the vicinity of the furnace during fluxing operations where it should not exceed 10 parts per million.

CARBON TETRACHLORIDE

Solvent vapor exposure is not ordinarily contemplated in connection with foundry operations but where thin sections require smooth finishes, as in aeroplane engine cylinder block castings, carbon tetrachloride has been used in connection with resin core washes. Here it is necessary to guard not only against the exposure to the carbon tetrachloride vapor itself but also to make sure that there is no possibility of exposure to phosgene into which the carbon tetrachloride is hydrolyzed if this vapor comes in contact with incandescent surfaces in core ovens or from molten metal or freshly poured castings. Phosgene has its purposes as a war gas but it has no place in the foundry.

In testing the sulphur content of the sand in the magnesium foundry, the reagent, carbon disulphide, is employed. It is probable that sufficiently small amounts of this solvent are used that exposures would not normally reach injurious amounts but where such tests may be made in small unventilated rooms, careless handling of carbon disulphide may permit concentrations of the highly poisonous vapor to reach injurious limits. In fact if more than three hundredths of an ounce of carbon disulphide is spilled and completely vaporized in a room of 1000 cubic feet, the safe concentration for this vapor will be exceeded.

Old Processes Presenting New Health Hazards

Not only are occupational health hazards being introduced with new industries but also in connection with many operations which have been conducted for many years. This is due to substitution of more injurious materials for those formerly used; due to requirements for greater precision as in the case referred to above; and due to specifications necessary to meet the requirements of national defense products.

BENZOL

In a great many operations where thinners for lacquers, dopes and impregnation materials have contained a large proportion of the moderately injurious solvent, toluol, other thinners must now be found in view of the demand of the munitions industry for this material in the manufacture of trinitrotoluene. Benzol is admirably suited for such purposes and it is probable that this much more toxic solvent will find its way into many operations throughout industry.

Consequently wherever such thinners must be used, ascertain definitely whether they contain benzol. If satisfactory thinners can be obtained which do not include as toxic a material, then the preventive measures are just that much easier. It is believed that benzol will be used in a number of places where either its solvent properties or its price make substitution by other solvents infeasible. If benzol is used, then additional safe-guards should be provided to assure that the exposed workers will not develop benzol poisoning. Reference to the Industrial Hygiene Foundation staff will bring detailed directions of methods for avoiding such poisoning. Briefly these preventive measures consist of determining whether the exposure is excessive by use of urine-sulphate analysis or determination of benzol concentrations in the atmosphere, checking on the health of the worker by blood examinations and, where shown to be necessary, provision of further ventilation and other protective measures.

TOLUOL

Toluol has been referred to as of only moderate toxicity but exposure even to this solvent should be limited if injurious effects are to be avoided. In spray coating the inside of aeroplane fuselages with dope thinned with toluol, exposures have been sufficiently high to produce narcotic effects on the spray painter. The effect of such physiological action in relation to the productivity of the worker is evident when the actions of these spray coaters are noted. On coming out of the blind end of the fuselage after having completed the job, the worker has been observed to be somewhat groggy and has even forgotten that he had finished the job and had started to go back into the same fuselage to do the job all over again. *Narcotic effects of organic solvents as a result of brief exposure to a single high concentration do not ordinarily cause any lasting injury to health, but where such brief exposure is repeated time after time, then there is unquestioned injury.*

When such a condition is brought to the attention of any of us, it takes little application of common sense to appreciate immediately that the worker's exposure must be reduced but the facts are that such exposure was a part of regular operation until observed by a trained industrial hygienist making a survey of the factory. The worker did

not complain and the supervisor was apparently too busy with production to note the condition himself.

RADIOACTIVE MATERIALS

Special requirements of national defense have stimulated the use of radioactive lacquers for painting luminous dials for instrument boards and other devices which must be seen in the dark. In navy establishments all over the country, in work-places for luminous painting of watch and clock dials located principally in Connecticut, New York and Illinois and in other manufacturing plants where luminous dials have become a necessary incidental, there are now over a thousand workers, mostly female, engaged in this operation.

Following the classic poisoning cases in New Jersey in 1925, a thorough investigation of exposure to radioactive material and its effects was made by the United States Public Health Service. More recently a survey has been made under the direction of the National Bureau of Standards largely at the instigation of the U. S. Navy. This investigation has resulted in the publication of a Bureau of Standards Handbook on the safe handling of radioactive luminous compounds, the regulations of which should be rigidly followed wherever such operations are conducted.

The type of problem which requires the combined resources of the engineer and the chemist are well illustrated in the safe-guarding of this operation. The Bureau of Standards handbook stipulates that the worker shall not be exposed to a concentration of more than 10^{-11} curie per liter. In one installation, exhaust hoods have been provided but the exhaust ventilation had been reduced by means of blast gates to such an extent that the exposure approached the suggested limits. It was found that air velocities at the face of these hoods was as low as 10 feet per minute at the end of the line, that is, a barely perceptible air movement—in fact, perceptible only to delicate instruments for velocity measurements and actually imperceptible to the skin. On the suggestion that the velocity be increased, objection was raised that this would cause the luminous paint to dry out too rapidly and so spoil the work. From the chemical point of view the situation was then taken care of by the suggestion that a series of less volatile solvents and plasticizers be used in the luminous paint which would give the same drying properties with the increase in ventilation.

CHLORINATED COMPOUNDS

Specifications necessary for the requirements of national defense presents a number of additional problems. Where it is essential that the Navy have slow burning cables which must pass rigid fire-resistive tests, chlorinated naphthalene waxes are the logical materials for impregnation of asbestos insulation. Due to poisoning by excessive exposure to certain of these chlorinated naphthalenes of persons who had impaired livers, a thorough investigation of these materials was made some years ago at the Department of Industrial Hygiene of the Harvard School of Public Health. Safe concentrations were established and regulations for its use were developed so that deleterious action could be avoided. With the greatly increased use of this synthetic wax in connection with defense requirements, there have been some hundred sixty-eight cases of dermatitis in one state and two cases of systemic poisoning. The manufacturers of the wax are well informed concerning its properties and methods of avoiding injurious results. They have done a splendid

job of drawing up control measures. The large group of cases is evidence that the user has not followed these good advices possibly due to the fact that he had not previously experienced difficulty when using this same material at this particular plant. Management should be alert to possibilities of injury as a result of increased exposures with accelerated production even where past years of moderately active operation have not resulted in obvious damage to health.

Apply Industrial Hygiene Methods

Just what should you do to assure that occupational environment is not causing injury to the health of the workers in your plant? What practices should you institute on returning to your plants which will make available the procedures which modern industrial hygiene methods have developed?

Many members of the Industrial Hygiene Foundation of America have already made a big start in utilizing the methods of industrial hygiene. Let me present a number of practical ideas to you for such use as may be suitable for your particular operation and organization. If certain of these procedures are already in force, as I know is the case in many of your plants, other phases of the program may be introduced to add to its effectiveness.

First, the attitude of management should be open to the value of industrial health as an integral part of effective production. Only with workers who are on their toes are you going to get the most out of your machine. We could name a number of manufacturers who are so distracted by the difficulties of obtaining the necessary materials, by the demands of labor in a laborers' market, by the need to meet rapidly approaching time limits that any thought of such an extraneous subject as health or hygiene has no entre to their time or to their minds.

Management problems are undoubtedly more difficult today than ever before in the history of economic organization but an open-minded attitude to industrial hygiene is a vital element in effective production.

Second, it is essential to have some one person at each plant who is responsible directly to management for control of occupational disease exposures. That one person should see to it that there is a catalog of all potentially hazardous materials and processes and that this list is kept up to date. He should keep in close touch with the purchasing department and with the engineering and development departments. Where materials or operations are introduced which may present health hazards, then he should obtain specific information on the possibilities involved. In addition to sources of information immediately available to him, such as published literature and texts on the subject together with information and advice from the medical department, he should consult with technical industrial hygiene services.

An effort should then be made to classify the various materials and operations into three groups: those which are obviously not of serious moment, those which may be expected to present a hazardous condition and require immediate control measures, and the intermediate group of conditions the hazards of which cannot be readily estimated by mere observation. The actual control will presumably be in the hands of the engineering and maintenance depart-

ments with determinations by industrial hygienists or specially trained persons to show whether the condition has been adequately controlled.

A number of these check methods can readily be carried out by engineers and chemists in the plant. Other operations may involve techniques with which these men are not familiar or require equipment which would not be justified as a permanent acquisition if it were to be used only at infrequent intervals and provided such equipment is available through some of the industrial hygiene services.

Industrial Hygiene Services

Of the industrial hygiene services, we refer you first to those of the Industrial Hygiene Foundation of America. Also, reference can be made to industrial hygiene departments of insurance companies extending compensation or group coverages if you happen to be carried by a company which includes such a staff in its organization. State industrial hygiene divisions are available in most of the industrial sections of the country and respond to requests for consultation or studies of industrial conditions as discussed earlier in this paper. A number of private consultants are available, especially where confidential relationships are desirable or required.

Where it may be difficult to obtain materials for carrying out engineering control of occupational disease hazards because of priorities, it has been suggested by the National Institute of Health that, after an application is filed with the Division of Priorities on Form PD-1, it would be helpful to have the state industrial hygiene bureau prepare a written statement on the importance of obtaining these required materials, which statement the management should attach to its application.

After this second item of assuring that environmental working conditions are satisfactory, attention should be given to a third factor of especial importance in reducing absenteeism. This is education of the worker in good health practices. Although reduction of non-occupational disability may not be the direct responsibility of the employer, it presents an opportunity for big returns.

Task of Employer

With trained workers at such a premium, the fact that the non-occupational disability causes an average of about fourteen times the absenteeism occasioned by the occupational disability demands an effective program to combat this huge waste. And what can the employer do about this? The medical department of course has a large part to play—this has been ably discussed by a number of industrial physicians at a number of meetings. Beyond the direct activity of the medical department and in those plants which are not large enough to support a medical department, management should see to it that the employee develops an appreciation of the advantages of good health and the accepted methods of attaining it.

A program which is being introduced by an increasing number of concerns includes discussion of causes of non-occupational disability in the committee meeting formerly devoted entirely to safety within the plant. A record of non-occupational as well as occupational disabilities—the NOD as well as the OD—is made in the minutes of the

(Concluded on page 25)

Metal Coatings On Non-Conducting Materials

PART II

By Samuel Wein

New York

CHATTAWAY

Chattaway's formula¹⁴ using phenyl hydrazine instead of formaldehyde is made up of:

Sol. No. 1	Phenyl hydrazine	1 part
	Water	2 parts
Sol. No. 2	Conc. sol. of copper sulphate in conc. ammonia	
Sol. No. 3	Potassium hydroxide	10 parts
	Water	100 "

Mix two parts of Solution No. 1 and 1 part of Solution No. 2. Warm and add Solution No. 3 after being warmed to such extent that a permanent turbidity from precipitating copper monohydrate results. The mirror will form in about an hour, keeping the solution warm at all times.

Hydrazine sulphate in the place of phenyl hydrazine (base) appears to have one advantage, i.e., ease of solubility in water permitting aqueous solutions.

14. Chattaway, Proc. Roy. Soc. (A) **88**, 88 (1907);
Chem. News **96**, 85 (1907); Chem. Abst. **2**, 926 (1908).

FRENCH

French¹⁵ used copper mirrors for special search-lights during the war periods of 1914-1918. The solutions he used consisted of:

Sol. No. 1	Conc. copper hydrate in conc. ammonia (Sp. Gr. 0.98)	
Sol. No. 2	Hydrazine sulphate	60 g.
	Water	1,000 cc.
Sol. No. 3	Potassium hydroxide	111 g.
	Water	1,000 cc.

The solution which has a clear, yellow color in the beginning, turns first dark-green, then pink. After about 20 minutes, the copper mirror is formed. A second coat can be applied in the same way.

15. F. French, Trans. Opt. Soc. (London) **25**, 229 (1923-4).

HUTTIG AND BRODKORT

Huttig and Brodkort¹⁶ find that if copper hydride (as well as the other metal hydrides) are heated, they are decomposed, leaving a film of copper on the surface on which it has been poured and subjected to the elevated temperature. This was later on verified by Wagner¹⁷. The temperature given by these investigators is between 250 to 300° C. This is best accomplished in the presence of hydrogen or illuminating gas.

16. Huttig and Brodkort, Zeit. f. Anorganische Allgem. Chem. **153**, 235 (1926); Zeit. f. Angew. Chem., **39**, 67 (1926).

17. Wagner, Oestr. Chem. Zeit. **48**, 425 (1937).

In this installment the author concludes his discussion of copper mirrors or films. The literature pertaining to gold films, lead sulphide films and nickel films is reviewed.—Ed.

VORLANDER AND MEYER

Copper hydride may be made according to Vorlander and Meyer¹⁸ from a solution of 75 grams copper sulphate and is reduced with $H_6P_2O_4$, prepared from 100 grams $Na_6P_2O_4$ and 310 grams sulphuric acid, density 1.130. The combined solutions are warmed at 40 to 50° C. The red brown powder is preserved in a moist state. Copper hydride must not be dried in vacuo and exposed to the air, since it then detonates.

18. Vorlander and Meyer, Ann. **329**, 143 (1902).

The larger producers of mirrors are all producing copper mirrors on glass. However, none of these firms do jobbing for copper films on other materials than glass. One manufacturer† supplies a three solution kit set, which, by following his instructions will give rise to a copper film of excellent tenacity on glass.

† Name furnished on request.

Gold Films

The fundamental idea of forming films of gold is to make an aqueous solution of gold chloride, either neutral or to render it slightly alkaline. The reducing agents as in the case of silver films are alcohol, invert sugar, citric acid, formaldehyde, etc.

ANDRES SOLUTION

Andres¹⁹ forms the gilding solution from:

Sol. No. 1—Gold chloride	1 oz.
Water	32 "
Sol. No. 2—Sodium or potassium carbonate	1 "
Water	8 "
Sol. No. 3—Formaldehyde	1 "
Water	16 "

Solutions No. 2 and No. 3 are mixed and to this are added from 1 to 5 grams of basic mercuric salicylate.

The last named mixture is mixed in equal portions with solution No. 1 onto the given surface. Here the inventor shows a spray in which both solutions are simultaneously emanating from a common source and onto the given surface.

19. Andres, U. S. Patent No. 1,953,330, Apr. 3, 1934.

BOETTGER FORMULA

The following formula is recommended by Prof. Boettger:

Sol. No. 1—Gold chloride	2 grams
Water	120 cc.
Sol. No. 2—Sodium hydroxide	6 grams
Water	100 cc.
Sol. No. 3—Glucose	2 grams
Water	24 cc.
After this latter solution is completed, there is added	
Sol. No. 4—Alcohol (80%)	24 cc.
Formaldehyde	24 "

Of the foregoing solutions use:

Solution No. 1	64 parts
Solution No. 2	16 "
Solution No. 3	1 part

Great care must be exercised in neutralizing the gold chloride solution.

A less troublesome solution for gilding is made up of:

Sol. No. 1—Gold chloride	3 grams
Water	80 cc.
Sol. No. 2—Sodium carbonate	8 grams
Water	80 cc.
Sol. No. 3—Formaldehyde (40%)	5 "
Water	80 "

For forming the gold film, Solutions 1, 2 and 3 are mixed in equal portions.

Lead Films

The formation of metallic sulphide films are accredited to Hauser and Bielecki,²⁰ in which an aqueous solution, let us say in this case a nitrate, acetate or tartrate, is mixed with a solution of thiourea in the presence of sodium or potassium hydroxide.

The coatings made of lead sulphide are used as "gun metal finish" mirrors (anti-glare type) for use in automobiles, high resistance units, etc.

The films are formed in the same manner as in the case of silver mirrors; i.e., by washing the surface treatment with a solution of tin chloride and then pouring the mixed lead sulphide solution.

A solution is made up of:

Thiourea	1 g.
Water	50-75 cc.

(To be Continued in February issue)

To this add 50 to 75 cc. of a dilute solution of lead acetate and finally 25 cc. of a dilute potassium hydroxide or ammonia solution, mixing continuously.

20. Hauser and Bielecki. Chem. Zeit. 34, 1079 (1910); ibid. 5, 437 (1911).

COLBERT SOLUTION

The formula patented by Colbert & Colbert²¹ consists of three solutions, and these are:

Sol. No. 1—Lead acetate	1 oz.
Water	24 "
Sol. No. 2—Sodium hydroxide	2 "
Water	32 "
Sol. No. 3—Thiourea	1 "
Water	48 "

The temperature suggested is 95° F. at the surface where the deposition is to be carried on.

Solution Nos. 1 and 3 are then mixed in the proportions of 4 parts Solution No. 3 to 1 part of Solution No. 1. Thereafter Solution No. 2 is added to the mix, to the extent of 1 part of Solution No. 2, and 5 parts of combined Solution Nos. 1 and 3.

21. Colbert, U. S. Patent Nos. 1,603,936, Oct. 19, 1926; 1,662,564, Mar. 13, 1928; 1,662,565, Mar. 13, 1928.

Nickel Films

Nickel carbonyl was proposed by Fink and Knight²² as a basis for forming metallic nickel films on the inner walls of a Dewar or so-called "vacuum flask" (Thermos bottle).

The nickel carbonyl is poured onto the given surface and at 150° C. it is decomposed to form carbon monoxide and metallic nickel, the latter being deposited in an adherent film on the surface upon which the solution was poured. If the surface is smooth and polished, the resulting deposit of nickel will also have a polish, and this latter will decrease with the thickness of the deposit, as might be expected. On to this film of metallic nickel may be deposited any other metal, and without any preparation whatever.

A serious objection in the use of nickel carbonyl is the fact that it is so poisonous.

22. Fink and Knight Jr., U. S. Patent No. 1,818,476, June 28, 1931.

INDUSTRIAL HYGIENE AT WORK

(Concluded from page 23)

committee meetings. To offer various phases of the health story in entertaining and readily acceptable form, strip film talkies are presented to the group on such fundamental subjects as the common cold. Nutrition, sleep and properly regulated exercise are covered for presentation from month to month in a continuing program. To carry the message beyond the immediate stimulation of the meeting, illustrated folders are distributed for the worker to take home. This and other devices are utilized to extend his interest over the full twenty-four hours every day—at home as well as

at work. The part of the industrial physician and the industrial nurse is to be stressed but a further effort should be made by these groups and also by management to institute an organized plan to reach the ultimate consumer, the worker himself.

In conclusion, let me urge you to place the modern methods of industrial hygiene into effect both for the control of industrial health hazards and for the reduction of non-occupational disability. Keep the manpower in your plants active and alert, physically and mentally, through adequate health supervision. Put industrial hygiene to work in your operation, whether or not it be a defense industry.

Fundamentals of Science Relating to Electroplating

Chapter X. Polarization-Overvoltage

FOR the present at least, overvoltage will be restricted to the phenomenon associated with the liberation of gas at an electrode. If platinum electrodes, coated with sooty platinum black, are immersed in a weak sulfuric acid solution, hydrogen may be evolved at the cathode and oxygen at the anode by applying voltage just slightly higher than that necessary to overcome the resistance of the solution. The voltage at each electrode in such a case is at a minimum. If electrodes of different material, such as smooth platinum, or iron, etc., are used, an appreciably higher voltage must be used. In the latter case, the higher potential, as compared with platinized platinum, necessary for the discharge of hydrogen and oxygen is known as **HYDROGEN OVERVOLTAGE** or **OXYGEN OVERVOLTAGE**, respectively.

The values of overvoltage vary from very low values of the order of a hundredth of a volt, to values in the neighborhood of 1 volt, depending upon many factors. One of the most important factors is composition of the electrode and in Table X typical values of hydrogen overvoltages are given for various metal electrodes. Table XI gives values for oxygen overvoltage. The physical condition of the surface is also important, the rougher surfaces giving lower values than the smooth ones, as may be judged by a comparison of platinized platinum with smooth platinum and spongy nickel with smooth nickel. Other factors are tempera-

Table X

Hydrogen Overvoltages (in 2N sulfuric acid, at 25° C and 0.001 amp./dm.²) After Mantell.

Cathode Material	Hydrogen Overvoltage
Aluminum	0.56
Bismuth	.78
Brass	.50
Cadmium	.98
Copper	.48
Duriron	.20
Gold	.24
Graphite	.60
Iron	.40
Lead	.52
Mercury	.9
Monel	.28
Nickel	.56
Palladium	.12
Platinum (platinized)	.015
Platinum (smooth)	.024
Silver	.47
Tellurium	.4
Tin	.86
Zinc	.72

ture (which usually decreases overvoltage), solution composition (such as permitting the adsorption of colloids on the electrode surface), and other influences less important and significant. Also, overvoltage exists for gases other than hydrogen and oxygen, namely the halogens, chlorine, bromine and iodine.

Many theories have been proposed to explain overvoltage, but none has been sufficiently impressive to receive universal and exclusive acceptance. Since it is thus difficult to actually explain overvoltage, and to know exactly what function to investigate, several methods have been used to measure it, and overvoltage is, in fact, often defined in terms associated with the method of measurement rather than in terms of some specific property. For these reasons, the values of overvoltage, even for the same

Table XI

Oxygen Overvoltages (in 2N sulfuric acid, at 25° C and 0.001 amp./dm.²) After Mantell.

Anode Material	Oxygen Overvoltage
Copper	0.42
Gold	.67
Graphite	.53
Nickel (smooth)	.35
Nickel (spongy)	.41
Platinum (platinized)	.40
Platinum (smooth)	.42
Silver	.58

material, vary appreciably and it is possible only to indicate the order of magnitude of the overvoltage rather than the exact values. From a practical point of view, however, especially in view of all the factors which affect the values, this lack of precise definition and reproducibility is no serious handicap.

But what are the practical applications of overvoltage? From the electroplaters' point of view the question is naturally associated with the simultaneous, and relative ease of, plating hydrogen and some metal. For example, to judge from the Electromotive Series (discussed in a previous chapter) it would normally require a higher voltage to deposit such metals as zinc, cadmium, iron and nickel from acid solutions of their ions than it would take to deposit hydrogen. It would seem, therefore, that from such solutions mostly hydrogen and very little metal, if any, would be plated. Fortunately, the hydrogen overvoltage on these metals is fairly high, as may be seen from Table X, so that actually the metal and

not hydrogen is preferentially plated in most cases. In other words, the active increased difficulty of discharging hydrogen on surfaces of zinc, cadmium, iron and nickel more than compensate for the "intrinsically" higher voltages, compared with hydrogen, that would be necessary to plate these metals if hydrogen overvoltage did not exist. For example, neglecting overvoltage, it would require approximately 0.2 volt more to deposit nickel from a "normal" solution than to discharge hydrogen from a "normal" solution. Actually, due to a hydrogen overvoltage on nickel of about 0.5 volt, it requires, under certain conditions, about 0.3 volt more to discharge hydrogen on nickel than to plate nickel on nickel. Acid nickel solutions are therefore practical and feasible because of hydrogen overvoltage. At the same time, as previously discussed, these deposition and discharge voltages may be varied by varying the concentration in the bath of nickel and hydrogen (pH). The relative ease of deposition of both these elements therefore also varies so that the efficiency of a nickel bath depends on, among other things, the nickel concentration and the pH.

There are other applications of overvoltage which will become evident when the peculiarities of various metals and their deposition are individually discussed. In chromium plating, for example, one reason for difference in ease of covering the cathode is the variation of hydrogen overvoltage with cathode composition and even with surface condition. The latter includes not only original mechanical finish, but also such effects as reduction of oxidized nickel with consequent somewhat spongy surfaces. In other cases, such as the production of chemicals by electrochemical oxidation and reduction, at the anode and cathode respectively, the very success of the process may depend on the use of the right electrode material for the proper overvoltage. Still another example is the "reciprocal" effect on some electrodes e.g. the absorption of hydrogen in iron cathodes with resulting change in electrode potential and overvoltage, which in turn further influence the cathode reaction.

We have so far discussed various forms of polarization including overvoltage. It has been stated previously that some ambiguity exists in the use of the various terms, which are so closely related that it becomes merely a matter of arbitrarily adopting definitions, if confusion is to be avoided. In order to clarify the situation, Blum and Vinal proposed in 1934, in the Transactions of the Electrochemical Society,

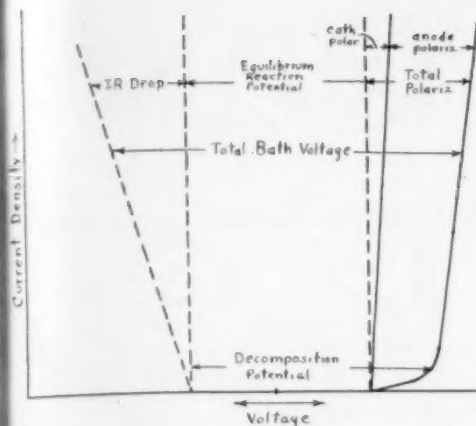


Fig. 14. Miscellaneous voltages in an electroplating bath.

certain definitions for the above related terms. The following discussion and Figure 14 are quoted therefrom or based upon that publication.

(a) **EQUILIBRIUM REACTION POTENTIAL** is the minimum voltage at which an electrochemical reaction can take place and is equal to the algebraic difference of the equilibrium potentials of the anode and cathode with respect to the specified reaction. For example, in an acid copper plating solution using lead anodes, the reaction at the cathode is the formation of copper from copper sulfate and at the anode it is the liberation of oxygen, since the lead is insoluble. The equilibrium voltage for the cathode copper deposition is +0.30 volt and the equilibrium voltage for the anodic oxygen liberation is +1.23 volts. The algebraic difference, or 0.93 volt, is therefore the equilibrium potential for the complete reaction. Since this value is independent of current density, it is represented in Figure 14 by the constant difference between the two vertical dotted lines.

(b) The voltage needed to overcome the resistance of the solution, known as the **IR DROP**, is represented in Figure 14 by the inclined line at the extreme left.

(c) **DECOMPOSITION VOLTAGE** is the minimum voltage, exclusive of that due to the resistance of the solution (the IR drop), at which an electrochemical reaction can take place continuously at an appreciable rate.

It will be noted from Figure 14 (solid curve at extreme right), that as the voltage increases, at the beginning very little current passes, and then suddenly the curve breaks and becomes almost vertical, showing a large increase in current. The voltage corresponding to the break in the curve, after deducting the IR drop, is the decomposition voltage.

(d) **POLARIZATION** is a change in the potential of an electrode during electrolysis such that the potential of an anode always becomes more positive (more noble) or that of a cathode becomes more negative

(less noble) than their respective equilibrium potentials. Polarization is equal to the difference between the equilibrium potential for a specified electrode reaction and the potential when a current is flowing.

In Figure 14, the total polarization is indicated by the distance between the solid curve on the right and the right vertical dotted line. The intermediate solid line shows what proportion of the total polarization is anodic and what proportion is cathodic. In this particular case, it will be seen that the anodic greatly exceeds the cathodic polarization. This is due to the use of the insoluble lead anodes. If the anodes were of copper, as is usually the case, the anode polarization would be greatly reduced and approximately equal to that at the cathode.

(e) **OVERVOLTAGE** is the minimum polarization at which a particular reaction occurs at an appreciable rate on a specified electrode or at which there is a marked increase in current density when the voltage is increased by only a small amount.

From Figure 14 it is evident that the break in the right hand polarization curve mentioned above for decomposition voltage, denotes also the point corresponding to overvoltage. In fact, overvoltage is equal to decomposition voltage minus the equilibrium reaction potential, which is in accordance with the implication of the name, i.e. a voltage over and above the equilibrium value.

As previously stated, overvoltage is usually restricted to the phenomenon associated with the evolution of gas, so that the above definition can be rephrased to mean the minimum polarization at which definite gas evolution may be observed. It is apparent, too, that overvoltage is generally associated with properties of the electrode itself, such as composition and surface condition, whereas polarization otherwise is associated with the properties of the electrolyte, either as a whole or as an electrode film.

(f) It is evident from the above that several factors make up the **TOTAL BATH VOLTAGE**. This voltage is the value read on a voltmeter connected across the anode and cathode of a plating solution, for example, during electrolysis or plating. From Figure 14, the total bath voltage will be seen to be equal to the sum of the equilibrium reaction potential, the IR drop and the polarization potentials at both anode and cathode. The least value of the bath voltage is obviously slightly greater than the decomposition potential.

Before concluding this general section on polarization, it may be well to briefly describe a method of measuring it that has gained popularity for its many practical applications. It was originally described by Haring and Blum in the Transactions of the American Electrochemical Society in 1926. It utilizes a small plating cell, known as the Haring cell, which is illustrated in Figure 15.

For determining polarization, the cell is filled with plating solution to a predeter-

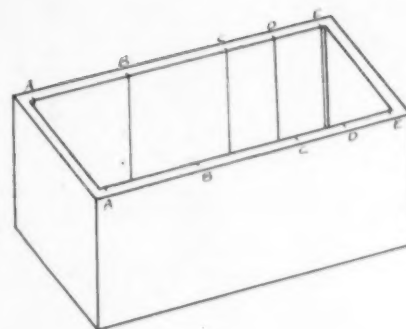


Fig. 15. Haring cell.

mined level and a cathode inserted in the slats at AA reaching to the bottom of the cell, and similarly an anode is inserted at EE. Strips of gauze, previously plated in the solution, are inserted at BB and CC. By using gauze instead of solid electrodes, the solution is permitted to diffuse or otherwise move through them, thus removing the effects of concentration films and of the resulting polarization, which would otherwise arise since one side of the electrode will act as a cathode and the other as an anode during plating. It is considered, therefore, that during plating no polarization exists at these gauze electrodes.

The entire cell is thus divided into three equal compartments, having equal electrical resistance and therefore equal IR drop. When current flows, the voltage in the first equals the anode polarization voltage plus the IR drop; the voltage in the second is only IR drop, since polarization has been eliminated by the use of the gauze; the voltage in the third compartment equals the cathode polarization plus the IR drop.

Mathematically then:

First compartment: $V_1 = V_{AP} + V_{IR}$

Second compartment: $V_2 = V_{IR}$

Third compartment: $V_3 = V_{CP} + V_{IR}$

Where V_1 , V_2 and V_3 are the respective compartment voltages as measured by a potentiometer or a high resistance voltmeter,

V_{AP} = anodic polarization voltage

V_{CP} = cathodic polarization voltage

V_{IR} = voltage due to IR drop

It is obvious that by subtracting V_2 (which is the same as V_{IR}) from V_1 and V_3 the anode and cathode polarizations respectively are directly obtained. Naturally the current, temperature, solution composition, etc. can be varied as desired and their effect on polarization thus determined.

The same cell may be used for measuring throwing power, by inserting an anode at DD and cathodes at AA and EE. The ratio of distances from the cathodes to the anode is therefore 5 to 1. By comparing the weights of metal deposited on these cathodes after a given time interval, an index of the throwing power of the bath, under the conditions in use, may be obtained. But the subject of "throwing power" is a story for another day.

Fundamentals of Science Relating to Electroplating

Chapter X. Polarization-Overvoltage

FOR the present at least, overvoltage will be restricted to the phenomenon associated with the liberation of gas at an electrode. If platinum electrodes, coated with sooty platinum black, are immersed in a weak sulfuric acid solution, hydrogen may be evolved at the cathode and oxygen at the anode by applying voltage just slightly higher than that necessary to overcome the resistance of the solution. The voltage at each electrode in such a case is at a minimum. If electrodes of different material, such as smooth platinum, or iron, etc., are used, an appreciably higher voltage must be used. In the latter case, the higher potential, as compared with platinized platinum, necessary for the discharge of hydrogen and oxygen is known as **HYDROGEN OVERVOLTAGE** or **OXYGEN OVERVOLTAGE**, respectively.

The values of overvoltage vary from very low values of the order of a hundredth of a volt, to values in the neighborhood of 1 volt, depending upon many factors. One of the most important factors is composition of the electrode and in Table X typical values of hydrogen overvoltages are given for various metal electrodes. Table XI gives values for oxygen overvoltage. The physical condition of the surface is also important, the rougher surfaces giving lower values than the smooth ones, as may be judged by a comparison of platinized platinum with smooth platinum and spongy nickel with smooth nickel. Other factors are tempera-

ture (which usually decreases overvoltage), solution composition (such as permitting the adsorption of colloids on the electrode surface), and other influences less important and significant. Also, overvoltage exists for gases other than hydrogen and oxygen, namely the halogens, chlorine, bromine and iodine.

Many theories have been proposed to explain overvoltage, but none has been sufficiently impressive to receive universal and exclusive acceptance. Since it is thus difficult to actually explain overvoltage, and to know exactly what function to investigate, several methods have been used to measure it, and overvoltage is, in fact, often defined in terms associated with the method of measurement rather than in terms of some specific property. For these reasons, the values of overvoltage, even for the same

not hydrogen is preferentially plated in most cases. In other words, the active increased difficulty of discharging hydrogen on surfaces of zinc, cadmium, iron and nickel more than compensate for the "intrinsically" higher voltages, compared with hydrogen, that would be necessary to plate these metals if hydrogen overvoltage did not exist. For example, neglecting overvoltage, it would require approximately 0.2 volt more to deposit nickel from a "normal" solution than to discharge hydrogen from a "normal" solution. Actually, due to a hydrogen overvoltage on nickel of about 0.5 volt, it requires, under certain conditions, about 0.3 volt more to discharge hydrogen on nickel than to plate nickel on nickel. Acid nickel solutions are therefore practical and feasible because of hydrogen overvoltage. At the same time, as previously discussed, these deposition and discharge voltages may be varied by varying the concentration in the bath of nickel and hydrogen (pH). The relative ease of deposition of both these elements therefore also varies so that the efficiency of a nickel bath depends on, among other things, the nickel concentration and the pH.

There are other applications of overvoltage which will become evident when the peculiarities of various metals and their deposition are individually discussed. In chromium plating, for example, one reason for difference in ease of covering the cathode is the variation of hydrogen overvoltage with cathode composition and even with surface condition. The latter includes not only original mechanical finish, but also such effects as reduction of oxidized nickel with consequent somewhat spongy surfaces. In other cases, such as the production of chemicals by electrochemical oxidation and reduction, at the anode and cathode respectively, the very success of the process may depend on the use of the right electrode material for the proper overvoltage. Still another example is the "reciprocal" effect on some electrodes e.g. the absorption of hydrogen in iron cathodes with resulting change in electrode potential and overvoltage, which in turn further influence the cathode reaction.

We have so far discussed various forms of polarization including overvoltage. It has been stated previously that some ambiguity exists in the use of the various terms, which are so closely related that it becomes merely a matter of arbitrarily adopting definitions, if confusion is to be avoided. In order to clarify the situation, Blum and Vinal proposed in 1934, in the Transactions of the Electrochemical Society,

Table XI
Oxygen Overvoltages (in 2N sulfuric acid, at 25° C and 0.001 amp./dm.²)
After Mantell.

Anode Material	Oxygen Overvoltage
Copper	.42
Gold	.67
Graphite	.53
Nickel (smooth)	.35
Nickel (spongy)	.41
Platinum (platinized)	.40
Platinum (smooth)	.42
Silver	.58

material, vary appreciably and it is possible only to indicate the order of magnitude of the overvoltage rather than the exact values. From a practical point of view, however, especially in view of all the factors which affect the values, this lack of precise definition and reproducibility is no serious handicap.

But what are the practical applications of overvoltage? From the electroplaters' point of view the question is naturally associated with the simultaneous, and relative ease of, plating hydrogen and some metal. For example, to judge from the Electromotive Series (discussed in a previous chapter) it would normally require a higher voltage to deposit such metals as zinc, cadmium, iron and nickel from acid solutions of their ions than it would take to deposit hydrogen. It would seem, therefore, that from such solutions mostly hydrogen and very little metal, if any, would be plated. Fortunately, the hydrogen overvoltage on these metals is fairly high, as may be seen from Table X, so that actually the metal and

Table X

Hydrogen Overvoltages (in 2N sulfuric acid, at 25° C and 0.001 amp./dm.²)
After Mantell.

Cathode Material	Hydrogen Overvoltage
Aluminum	0.56
Bismuth	.78
Brass	.50
Cadmium	.98
Copper	.48
Duriron	.20
Gold	.24
Graphite	.60
Iron	.40
Lead	.52
Mercury	.9
Monel	.28
Nickel	.56
Palladium	.12
Platinum (platinized)	.015
Platinum (smooth)	.024
Silver	.47
Tellurium	.4
Tin	.86
Zinc	.72

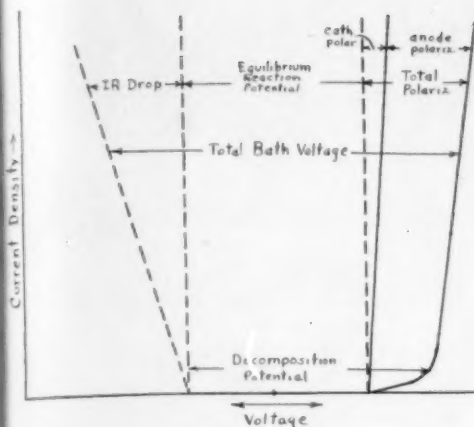


Fig. 14. Miscellaneous voltages in an electroplating bath.

certain definitions for the above related terms. The following discussion and Figure 14 are quoted therefrom or based upon that publication.

(a) **EQUILIBRIUM REACTION POTENTIAL** is the minimum voltage at which an electrochemical reaction can take place and is equal to the algebraic difference of the equilibrium potentials of the anode and cathode with respect to the specified reaction. For example, in an acid copper plating solution using lead anodes, the reaction at the cathode is the formation of copper from copper sulfate and at the anode it is the liberation of oxygen, since the lead is insoluble. The equilibrium voltage for the cathode copper deposition is +0.30 volt and the equilibrium voltage for the anodic oxygen liberation is +1.23 volts. The algebraic difference, or 0.93 volt, is therefore the equilibrium potential for the complete reaction. Since this value is independent of current density, it is represented in Figure 14 by the constant difference between the two vertical dotted lines.

(b) The voltage needed to overcome the resistance of the solution, known as the **IR DROP**, is represented in Figure 14 by the inclined line at the extreme left.

(c) **DECOMPOSITION VOLTAGE** is the minimum voltage, exclusive of that due to the resistance of the solution (the IR drop), at which an electrochemical reaction can take place continuously at an appreciable rate.

It will be noted from Figure 14 (solid curve at extreme right), that as the voltage increases, at the beginning very little current passes, and then suddenly the curve breaks and becomes almost vertical, showing a large increase in current. The voltage corresponding to the break in the curve, after deducting the IR drop, is the decomposition voltage.

(d) **POLARIZATION** is a change in the potential of an electrode during electrolysis such that the potential of an anode always becomes more positive (more noble) or that of a cathode becomes more negative

(less noble) than their respective equilibrium potentials. Polarization is equal to the difference between the equilibrium potential for a specified electrode reaction and the potential when a current is flowing.

In Figure 14, the total polarization is indicated by the distance between the solid curve on the right and the right vertical dotted line. The intermediate solid line shows what proportion of the total polarization is anodic and what proportion is cathodic. In this particular case, it will be seen that the anodic greatly exceeds the cathodic polarization. This is due to the use of the insoluble lead anodes. If the anodes were of copper, as is usually the case, the anode polarization would be greatly reduced and approximately equal to that at the cathode.

(e) **OVERVOLTAGE** is the minimum polarization at which a particular reaction occurs at an appreciable rate on a specified electrode or at which there is a marked increase in current density when the voltage is increased by only a small amount.

From Figure 14 it is evident that the break in the right hand polarization curve mentioned above for decomposition voltage, denotes also the point corresponding to overvoltage. In fact, overvoltage is equal to decomposition voltage minus the equilibrium reaction potential, which is in accordance with the implication of the name, i.e. a voltage over and above the equilibrium value.

As previously stated, overvoltage is usually restricted to the phenomenon associated with the evolution of gas, so that the above definition can be rephrased to mean the minimum polarization at which definite gas evolution may be observed. It is apparent, too, that overvoltage is generally associated with properties of the electrode itself, such as composition and surface condition, whereas polarization otherwise is associated with the properties of the electrolyte, either as a whole or as an electrode film.

(f) It is evident from the above that several factors make up the **TOTAL BATH VOLTAGE**. This voltage is the value read on a voltmeter connected across the anode and cathode of a plating solution, for example, during electrolysis or plating. From Figure 14, the total bath voltage will be seen to be equal to the sum of the equilibrium reaction potential, the IR drop and the polarization potentials at both anode and cathode. The least value of the bath voltage is obviously slightly greater than the decomposition potential.

Before concluding this general section on polarization, it may be well to briefly describe a method of measuring it that has gained popularity for its many practical applications. It was originally described by Haring and Blum in the Transactions of the American Electrochemical Society in 1926. It utilizes a small plating cell, known as the Haring cell, which is illustrated in Figure 15.

For determining polarization, the cell is filled with plating solution to a predeter-

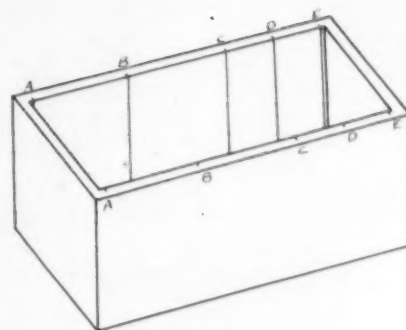


Fig. 15. Haring cell.

mined level and a cathode inserted in the slats at AA reaching to the bottom of the cell, and similarly an anode is inserted at EE. Strips of gauze, previously plated in the solution, are inserted at BB and CC. By using gauze instead of solid electrodes, the solution is permitted to diffuse or otherwise move through them, thus removing the effects of concentration films and of the resulting polarization, which would otherwise arise since one side of the electrode will act as a cathode and the other as an anode during plating. It is considered, therefore, that during plating no polarization exists at these gauze electrodes.

The entire cell is thus divided into three equal compartments, having equal electrical resistance and therefore equal IR drop. When current flows, the voltage in the first equals the anode polarization voltage plus the IR drop; the voltage in the second is only IR drop, since polarization has been eliminated by the use of the gauze; the voltage in the third compartment equals the cathode polarization plus the IR drop.

Mathematically then:

First compartment: $V_1 = V_{AP} + V_{IR}$

Second compartment: $V_2 = V_{IR}$

Third compartment: $V_3 = V_{CP} + V_{IR}$

Where V_1 , V_2 and V_3 are the respective compartment voltages as measured by a potentiometer or a high resistance voltmeter,

V_{AP} = anodic polarization voltage

V_{CP} = cathodic polarization voltage

V_{IR} = voltage due to IR drop

It is obvious that by subtracting V_2 (which is the same as V_{IR}) from V_1 and V_3 the anode and cathode polarizations respectively are directly obtained. Naturally the current, temperature, solution composition, etc. can be varied as desired and their effect on polarization thus determined.

The same cell may be used for measuring throwing power, by inserting an anode at DD and cathodes at AA and EE. The ratio of distances from the cathodes to the anode is therefore 5 to 1. By comparing the weights of metal deposited on these cathodes after a given time interval, an index of the throwing power of the bath, under the conditions in use, may be obtained. But the subject of "throwing power" is a story for another day.

Crystal Transformation of White Tin

Q. As one of your subscribers, we would like to get some information regarding the effect of very low temperatures, such as -70°C . on electrodeposited tin. We would like to know if there is any information available on the so-called "tin pest" transformation of white tin to another allotropic form. The tin has been deposited upon brass to a thickness of 0.0005".

A. In response to your inquiry regarding "tin pest" attack on electroplated brass at -70°C ., I am glad to submit the following:

The transformation of white tin to the grey modification rarely occurs in practice and is still to be regarded as a scientific curiosity, since conditions are seldom favorable for the change. Slight impurities in the tin, such as bismuth or antimony, effectively prevent the transformation. The presence of cadmium, lead, silver and gold also retard the transition (but to a lesser extent), while zinc and aluminum additions favor it. Speed of transition and its likelihood become greater as the temperature decreases, reaching a maximum at about -40°C . As lower temperatures are reached, however, the rate of change diminishes, hence using the tinned brass at -70°C . does not particularly favor the transformation.

Mechanical working of the tin increases its tendency to undergo the transition when subjected to a relatively low temperature. Although the electroplated deposit is quite pure tin, favoring the transition, the very low temperature of use and absence of mechanical working should be sufficiently strong favorable factors to prevent any change. It would be best not to heat the electroplated brass in order not to favor inter-diffusion of zinc and tin, because of the effect of zinc in favoring the transition of white tin to grey tin. As far as known, there have been no cases of electroplated brass being disturbed by this transformation.—B. W. G.

Tinning Steel Pins

Q. We intend manufacturing steel pins similar to the sample enclosed. We desire to bright tin these pins and obtain the same finish and rust-proof quality. While we realize there are other rust-proofing methods on the market, we like the bright luster of these pins and want to know if tinning is the best way to get this finish.

A. It is possible to put an immersion tin directly on steel pins, but the finish so obtained does not have good luster nor a good protective quality.

The better finish is obtained by electroplating the steel pins, and then tumbling to bring up the luster.

Technical Advisors For January Issue

BRUCE GONSER,

Battelle Memorial Institute
Columbus, Ohio

G. B. HOGABOOM, JR.,

Consultant in Electroplating, and Metal Finishing
Newark, N. J.

The pins are first cleaned and then plated in a hard rubber barrel made for handling pins, in a solution such as given on page 68 of the 1941 edition of the Plating & Finishing Guidebook, published by *Metal Finishing* magazine. The formula given†, as for control purposes, is:

Sodium stannate	20 oz.
Caustic soda	3 "
Sodium acetate	3 "
Hydrogen peroxide	1/16 "
Water to make	1 gal.
Operate at 160 to 180 deg. F.	

The time of plating can be from 15 minutes to 30 minutes. A better finish will be obtained on pins plated the longer time, and also there will be less likelihood of the tumbling causing the tin to be taken off the points.

After plating, rinse, and tumble the pins in a plain open end wood barrel, using soap solution. No balls are required. The pins are then rinsed, and tumbled in sawdust which will dry, and bring up some additional luster.

† The DuPont Co. Wilmington, Del. have several patents covering alkaline tin plating.—Ed.

Two-Tone Finishing

Q. We are enclosing a two-tone wedding ring and a two-tone mounting, white gold on yellow gold. We would like to be able to rhodium plate the white surfaces on the rings without affecting the yellow surfaces. We have experimented with using colorless lacquer as a stop-off and hand painting all the yellow surfaces, which we do not want to be electroplated. While the results were good, the method proved to be too costly, and in addition, any slip in the application of the lacquer would result in a spotty job with the rhodium plate covering spots that were left unprotected. This would necessitate re-buffing. The purpose of the rhodium plate is to whiten the white metal only. Any

suggestions you can give us on this problem, will be greatly appreciated.

A. No other method is known for doing this operation besides the one outlined above which is the general practice. However better results will be obtained if a pigmented lacquer is used instead of a clear lacquer, since the inspection will be made easier and deposition of rhodium on unpainted portions of the yellow gold sections will be minimized. The removal of the pigmented lacquer will be more difficult than the clear lacquer since there will be a tendency for the pigment to remain in the design after dipping in thinner to remove the lacquer film. However a boiling out operation or steaming will take care of this.

If the quantity in each style of ring warrants it, more rapid stopping off can be obtained by the use of stencils and spraying of the lacquer instead of hand painting.

Another method which is not commonly used involves the painting of the white gold with a water paste of umber. When this has dried the rings are dipped in the lacquer and dried. The lacquer will not adhere over the umber and can be cut out with a knife.

—G.B.H.Jr.

Wire for Racking

Q. We are having difficulty in obtaining copper wire for wiring up pieces to be plated. Can iron wire be used?

A. Soft iron wire has been used as a substitute for copper wire, but it is now not only difficult to obtain, but does not give satisfactory results. Being a poor conductor, good current distribution to all pieces is not had, and the wire may become hot making unloading of a tank troublesome. Good contact with the work rod is not always had due to the iron wire surface becoming corroded. Furthermore, the iron does not hold work closely as does copper wire and some pieces may fall out of loops.

If material can be obtained for making racks the necessity for obtaining repeated copper wire replacements will be eliminated.

Some saving of copper wire can be effected by eliminating the portion of the wire above the solution, and using hooks. The hook may be extended below the solution, as a straight piece and insulated except at the notch, hole, or small hook to which the copper wire is attached.

Copper wire that has been used can be straightened out, laid in bundles, and these heated to redness by a torch or in a furnace. Then plunge in cold water, to eliminate excessive oxidation in the air, and also to knock off some scale. Bright dipping will clean up the surface.

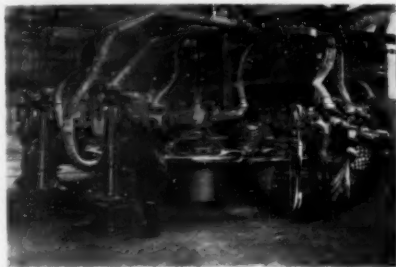
NEW EQUIPMENT AND SUPPLIES

NEW PROCESSES, MATERIALS AND EQUIPMENT FOR THE METAL INDUSTRY

Automatic Bumper Polishing and Buffing Machine

Acme Manufacturing Co., 1645 Howard Ave., Detroit, Mich., have recently developed an automatic machine for polishing and buffing of bumpers.

The machine is a continuous rotary type, which type the company has advocated for several years, to handle more efficiently the finishing of curved bumpers used on many automobiles today. Because the bumper travels in an arc conforming approximately to the radius of the work, the buffing wheel naturally follows the shape and covers more surface by assisting the flexible floating wheel to cover more area than could be obtained in conveying on a straight line.



Automatic bumper polishing and buffing machine.

The machine illustrated has a working table 18 ft. in diameter with nine adjustable toggle type holding fixtures. It is equipped with a variable speed control with an 8 ft. 3-pch gear driven by an 8-inch pinion positively permitting no back-lash to cause hesitation marks in the work. There are ten buffing heads around the table, each completely adjustable with an adjustable floating spindle equipped with a 15 H.P. totally enclosed fan-cooled ball bearing motor with V-belt drive for selected wheel speed.

The wheel spindles are raised and lowered through a $\frac{1}{2}$ H.P. V-belt motor drive mounted on the column which permits quick wheel change and re-set. The heads are of heavy cast iron construction, each weighing over 2,000 pounds, giving them real rigidity and smooth operation. These heads can normally be equipped with either 15 H.P. or 20 H.P. motors.

New Abrasive Blast Nozzle

American Foundry Equipment Co., 555 S. Byrkit St., Mishawaka, Ind., recently announced the development of an extremely hard, abrasion-resisting ceramic insert to be used with the company's "Long-Lyfe" nozzles.

The ceramic insert is claimed to have a hardness and density superior to many of the metals now being used for this purpose, and its manufacture is not affected by the present scarcity of certain metals. The reduction in wear is claimed to reduce the cost of compressed air and the maintaining of the contour of the blast stream is said to result in faster and more uniform cleaning.

The jacket enclosing the insert is also stated to be improved. Additional features of this nozzle include:

1. High finish bore; no soft spots to start uneven wear.
2. Non-metallic, thus reducing static to a minimum
3. Does not "bell out" rapidly.
4. Excellent mechanical strength.
5. Adaptable to any equipment.

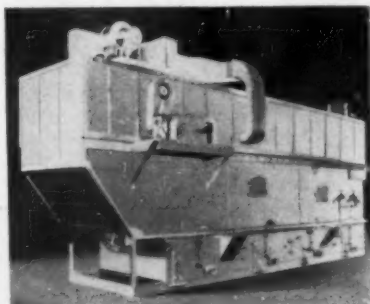
Two types of nozzles are available: The flange type and the screw type. Adapters can be supplied for fitting the nozzle to any type of air blasting equipment.

Processing Machine for Aluminum Alloys

The two-strand, cross-rod conveyORIZED processing machine shown in the photo herewith has been specially designed and built by Detroit Rex Products Co., 13005 Hillview Ave., Detroit, Michigan, for the cleaning and treatment of metal parts. It follows an approved U. S. Army and British procedure for the treatment of aluminum alloy sheets used in aircraft to make them less pervious to the effects of air, and to provide a better paint bond.

This machine incorporates hot alkali wash, hot water rinse, hot chromic acid dip, hot water rinse, and oven dry off.

The processing machine has the advantages of a compact self-contained unit that eliminates special handling systems and tanks spread out over a large floor space. Further floor saving is obtained by the oven being located over the top of the dip tanks,



Processing machine for aluminum alloys.

with the return flight of the conveyor passing overhead through the oven back to the loading-unloading station. Another important feature of this simplified and condensed set-up is that both steam and acid fumes are positively withdrawn from the plant so that operating conditions are greatly improved. This unit also makes important savings by eliminating rehandling the work.

It is fabricated from steel plate, reinforced with structural steel, and is of all-welded construction supported on structural steel sill. The oven paneling is insulated with fibre glass.

The hot alkali tank, hot water rinse tanks, and chromic acid tank are heated by multipass steam coils, tested for a working pressure of 200 lb. per sq. in. Each tank is equipped with a gauge glass, drain valve, direct-reading dial thermometer, and quick-opening clean-out door. The alkali and chromic acid tanks are equipped with charging hoppers. Each tank is provided with an overflowing scum trough. Large inspection doors are provided over the tanks and large access doors are located at the rear end of the unit (one over the final hot water rinse

Professional Directory

G. B. HOGABOOM JR. & CO.

Consulting Chemical Engineers

SALT SPRAY TESTING — CERTIFIED TO MEET ARMY AND NAVY SPECIFICATIONS. Testing of deposits-thickness, composition, porosity. Solution analyses, plant design, process development.

352 Mulberry St. Newark, N. J.

Platers Technical Service Co.

Electroplating and Chemical Engineers

Complete services, including solution analyses, process development and deposit tests. S. C. Taormina Tech. Director
Dr. C. B. F. Young Tech. Advisor
Dr. G. Amorosi Engr. Advisor
(Professional Engineer)

59 E. 4th St., N. Y. C. ORchard 4-1778

Joseph B. Kushner, Ch.E. Metal Finishing Consultant

Plating plants streamlined for defense work.

233 W. 26th St., N. Y. C.

tank and one in the oven). The hot chromic acid tank is supplied with a direct-acting, self-operated temperature regulator. Duct work and blower are arranged to exhaust from each end of the washer, and from the chromic acid stage. The dry-off oven is heated by a blast heater arranged for high pressure steam.

The conveyor drive is complete with roller chain drive, shear-pin-hub sprocket, double wormgear reducer, variable speed motor pulley and base.

These processing machines are built in various sizes to accommodate individual production requirements. The unit shown, for example, has the following approximate overall dimensions: Length, 29 ft. 10 in.; Width, 13 ft. 9 in.; Height, 14 ft. The work clearances through the machine will accommodate baskets 48 in. long by 18 in. wide by 12 in. deep (18 in. hanging from the center line of the crossrod to the bottom of the basket). The approximate weight is 17,400 lbs.

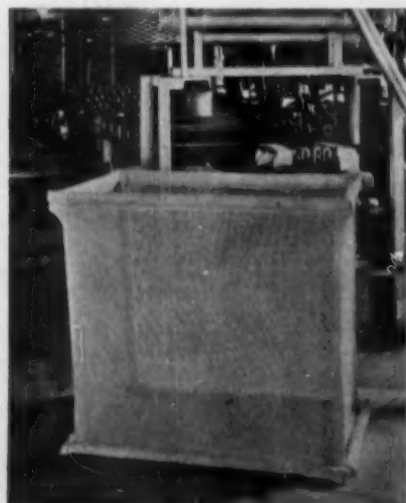
Plating Tank Nets

A new aid to electroplating practice has been placed on the market by Hanson-Van Winkle-Munning Company, Matawan, N. J. This device is a tank net. These nets are placed in plating tanks so that any work dropped may fall into the net; thus any work dropped is easily recovered by simply lifting the net out of the solution.

This net is made of $\frac{1}{2}$ " stretched mesh, hung square, 6 thread medium twine, made to dimensions as specified. Tape is sewn in form of loops along top and bottom of both ends and sides large enough to accommodate a rod up to $1\frac{1}{2}$ " in diameter.

These nets can be used in nickel, cyanide copper, alkaline zinc, acid zinc and cadmium solutions. They are not suitable for alkaline cleaners or sodium stannate tin solutions.

One of the largest camera manufacturers, and two of the best well-known optical concerns in the country, have been using nets of this type for the past two years in 9H nickel solutions with very satisfactory



Tank net for recovering dropped pieces in plating tanks.

results. These concerns plate mostly brass, copper and die cast parts which, when dropped to the bottom of the tank cannot be recovered with a magnet. They advise that contamination and consequent poor plating has decreased tremendously with the use of these nets.

New Plating Rack Coating

Detroit Rackote Co., have announced a new plating rack insulation material called "Waxkote", which is stated to be manufactured from a 100% air drying plastic, which is patented and the rights for the use of which are held by the company.

There is stated to be an abundant supply of raw materials for the rack coating and, therefore, no priorities are required. The coating material is claimed to be adhesive to all metals and the racks require no previous sand-blasting or taping.

The material is said to be easy to apply. It requires no drying, hardens quickly and a rack can be coated within five minutes. The coating is recommended for use in all type plating solutions and cleaners including, chromium, nickel, cadmium, copper, zinc and tin and also for anodizing.

Information and sample can be obtained by writing to Detroit Rackote Co., 4038 St. Clair Ave., Detroit, Mich.

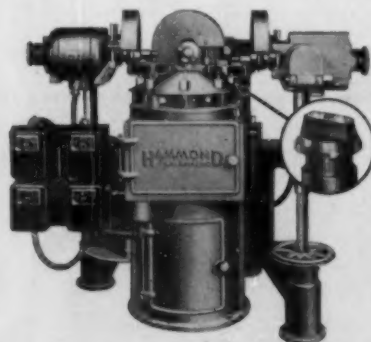
Rotary Automatic Polisher

For special "defense" polishing and buffing jobs, Hammond Machinery Builders, Inc., 1623 Douglas Ave., Kalamazoo, Mich., have developed a rotary automatic polishing machine capable of handling a wide variety of circular pieces.

Aluminum pistons for aircraft engines, fuse bodies, and engine valves, all are within the scope of this automatic machine. Other special jobs involving circular parts are also easily accomplished. To change from polishing or buffing of one piece to another of a different type requires a simple change of chucks.

The polisher consists of a circular aluminum table mounted over a heavy cast-iron base. The table indexes automatically, rotating 6 to 8 chucks which pass under as many as four polishing wheels mounted on rigidly constructed pedestals.

Chucks are stationary during loading or unloading. Spindles carrying the chucks



Rotary automatic polisher.

revolve with the table, which is driven by sprocket and chain from a speed reducer in the base of the machine. Speed changes are easily made, both in spindle revolutions and number of table indexes per hour.

Polishing wheels are independently driven, either by V-belts from motor or direct on motor spindle. Controls for all motors are mounted on a master control board conveniently located at front of the machine.

Buffing or polishing wheels may be adjusted to any angle desired to suit the work. Composition is applied to the wheel automatically by the company's "Autodoper", an accessory attachment.

Economy of time and materials, and faster, better finish are claimed to be accomplished by the new rotary automatic polisher. One operator is required to operate the machine economically. The machine shown is equipped to handle circular pieces.

Samples of work to be polished and/or buffed can be submitted to Hammond and on receipt of samples, full details relative to the particular operations necessary will be furnished.

Selenium for Rectifiers

Metallic selenium of the absolute purity which is required in electric current rectifiers is now being refined in the United States in commercial quantities to meet the requirements of the International Telephone & Radio Manufacturing Corporation for the manufacture of I.T. & T. Selenium Rectifiers.

Until this year only small quantities of selenium for rectifiers were required. The rectifiers had been manufactured on a steadily increasing scale since 1938 at the International Telephone & Radio Manufacturing Corp. factory at 137 Varick Street, New York but this was chiefly a preparatory period for the industry in establishing acceptance of the rectifier and setting the foundation for its production on a much larger scale. Early this year, the Company doubled its Varick Street space. Last month it started production of the rectifiers in its East Newark, N. J. factory where capacity is now ready, with the Varick Street facilities, to meet the heavy demand foreseen for 1942 on top of a very sharp increase this year. Applications for the selenium rectifier have been found in almost every phase of American industry, including aviation and other industries contributing heavily in the National Defense Program.

George Lewis, Vice President of International Telephone & Radio Manufacturing Corp. estimates that their requirements of ultra-refined selenium may be 10,000 pounds monthly next year compared with only 1,500 pounds monthly at present. Thus, the importance of the development of an ample supply of pure metallic selenium for the rectifier industry becomes apparent.

As for the raw material supply, selenium is found chiefly in copper ore and years ago it was tossed on the slag piles. In-

asmuch as the United States and Canada together normally produce two or three times more copper than the rest of the world combined, Mr. Lewis says that selenium is one metal of which a shortage seems unlikely in spite of its rapidly growing importance in the electrical industry.

Heating and Agitating Pickling Tanks

BY CARL E. HEIL

Heil & Co., Cleveland, Ohio

THE subject of heating and agitating pickling tanks has taken on a renewed interest recently through desire to increase production and reduce rejects without the expense and space necessary for additional tank units. Acid economy is also being stressed.

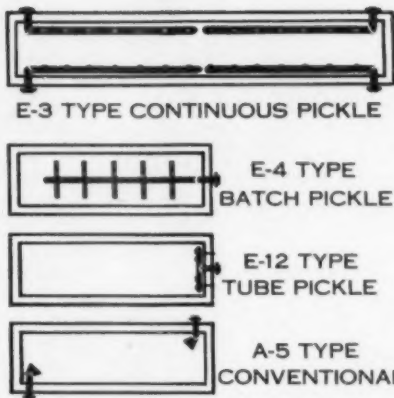
The speed-up can be accomplished by sufficient uniform heat together with thorough agitation of the bath. This has been proven by recent practical tests. It remains then a matter of securing equipment adequate to meet this need. The new "E-Series Steam-Air Agitator Jets" made by Heil & Company, of Cleveland, Ohio are designed for this job. Already installed in over 75% of the continuous sheet mills, these jets increase the tonnage speed through the pickling line from twenty to forty per cent.

Heating of most pickling tanks can best be accomplished with steam jets, which in addition to supplying the temperature requirements, also provide agitation over an area within range of the jet, pressure and volume of steam being the major factors therefor.

The outstanding feature of Heil jets is the orifice, a perforated "Nocorodal" (graphitic carbon) nozzle plate, secured at the tip of the jet. This material is unattacked by the acid solutions used and has unusual resistance to mechanical wear by steam. The patented jets have demonstrated long life



Steam jet agitator in continuous pickler.



Drawings of various types of arrangement of heating coils for pickling.

in severe service of pickling. The materials of which they are made will stand as much as 50% acid solution boiling, far above the usual concentrations called for in modern pickling practice. Many of the acid resisting metals in use in former years are now quickly consumed in the solutions demanded for use in modernized plants, where concentrations range to 20% and temperature close to boiling.

In the long continuous pickle tanks, the effective agitating range of conventional type jets is limited to areas near the corners. A large portion of these tanks has in the past had no agitating method provided, and a great deal of their useful area has not been fully utilized. Heil engineers have seized upon this opportunity to put this available equipment to work to increase the possible tonnage output. They have developed their E-3 Jets for this purpose. The jets are installed at the bottom of the tanks along the sides and extend to the middle of the tank from each end.

Nozzle openings are spaced at approximately 15-inch intervals and are located on the horizontal along one side of the tank and on the vertical of the other side. During operation, the pickle liquor is rapidly agitated and circulated from below and rolled over the top of the continuous strip in a rotating manner.

In past experience at the steel mills, the top side of the strip never received the same degree of pickling as the bottom, consequently either over-pickling of the bottom side resulted, or insufficient pickling on the top side. By the use of the new jets, greater uniformity results, permitting faster travel of the strip and thereby larger tonnage pickled.

Even though better agitation is secured from higher steam pressures, it must also be remembered that the tank heats up faster, and when the desired temperature is obtained steam is shut down and no agitation results during the ensuing period unless provided by other means.

It has been found that air agitation is quite beneficial speeding the acid action. Since the regular steam jets are already available, these can be made to work on air pressure automatically when the steam is off. The use of air agitation intermittent with the steam for heating by the jets, provides constant agi-

tation throughout the tanks, a result hitherto unattained in modern continuous practice. Air admitted with the steam is also an improvement over straight steam.

The use of air agitation has demonstrated several concurrent advantages, namely, a saving of acid consumption 10% and more, effective pickling at somewhat lower acid concentration, and finally an increase of tonnage pickled.

A modification of this system has also been devised for batch picklers and is referred to as "E-4" type. These are built tree-shaped for placement centrally on the bottom. A series of nozzles surges the pickle up through the sheets, which are usually set on edge during the processing. Rejects are greatly reduced, at the same time, eliminating the necessity of many hairpin spacers, sand, and other subterfuges for separating the sheets of coils.

The E-12 type steam-air agitators are designed for use in tube picklers, permitting either steam or air to be blown through the tubes. This rapidly removes the ganister, producing more effective pickling internally in a shorter period, with the consequent reduction of the usual over-pickling of the outer surface.

It is the writer's candid opinion, that executives in the steel industry have not given as thorough attention to the economies and practice in the pickling department as they have in the rolling division, following the rapid advance recently in that art. Much modern pickling equipment has been installed in recent years, a great deal of it vastly larger in size than any of the units from which previous useful experience has been derived. The writer trusts that some of the ideas incorporated above may suggest worthwhile improvements in other mills.

A New Method of Degreasing

The present shortage of chlorinated solvents due to the demand for chlorine in our War and Defense efforts has presented a problem to many manufacturers.

There have been two general methods of degreasing (without the use of inflammable materials, such as gasoline, etc.)

1. Chlorinated solvent degreasing, usually in the vapor phase. (Generally using trichlorethylene, under various trade names.)
2. Alkali cleaner, also sold under various trade names.

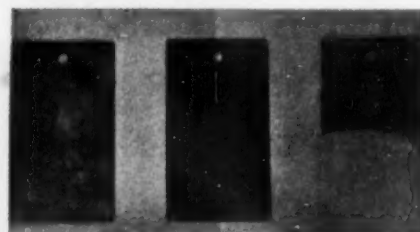


Fig. 1. On left is untreated panel. At center is panel after treatment, with the black oxide coating. The lower half of right panel was cleaned and subsequently pickled.

Chlorinated solvents very effectively remove greases and oil but do not remove solids. They can be re-distilled and re-used many times.

A new method of degreasing by means of catalyzed molten salts is now available from Kolene Corp., 315 Boulevard Bldg., Detroit, Mich., which is remarkably effective and economical, it is claimed.

This salt bath is maintained at temperatures from 600 to 900° F. and the degreasing operation is accomplished by the oxidation of all carbonaceous matter. The oxidation operation is followed by a water rinse.

The oxidized surface thus obtained is in itself somewhat corrosion resistant and can also be used for a paint base for some applications.

If, however, the color of the original metal such as steel, copper, etc., is desired, these

oxides are very readily soluble in a mild acid bath.

Figure No. 1 on the left shows a piece of hot rolled steel on which any amount of oil or grease could be placed. The center panel shows this same piece of steel after having been degreased. Note the black readily-soluble oxides on the surface.

The piece on the right at the bottom has been immersed in the catalyzed molten salt bath and then the entire specimen dipped in 8 to 10% hydrochloric acid for 15 seconds.

The upper half of this specimen was not immersed in the salt bath and it will be noted the hydrochloric acid had practically no effect on the surface after immersion.

While there are many jobs where temperatures over 600° F. will have no ill effects, naturally, there are some where this temperature would result in warpage, annealing,

or some other undesirable action. In these later cases this method of degreasing cannot be used.

One familiar with solvent degreasing knows the care taken to protect workmen from the toxic fumes produced by inclosing the operation. There are no toxic fumes from these salts but the same degree of care should be taken to protect the workmen from "spitting" of the hot salts when moist pieces are immersed.

The hot molten salt bath has no harmful effects on iron or steel; therefore, the pots for the degreasing operation can be of materials such as cast iron, boiler plate, etc., and heated by gas, oil, or electricity with any commercially practical control of the heat.

The heat required is not critical and may vary as much as 100 to 200° F.

It is possible to reconstruct some present commercial degreasing machines to use this catalyzed molten salt method of degreasing.

Because of the low surface tension of these salts, "drag-out" is very low and as they are water soluble, the salts in the "drag-out" can be re-claimed if desired, therefore, the operating cost after the initial installation is very low.

Thus far, none of the ingredients of this catalyzed molten bath are on priority and shipments at this writing are being made immediately.

New Tube-Type Rectifiers

The Weltronic Corp., 3099 E. Outer Dr., Detroit, Mich., have announced the development of a complete line of full-wave industrial rectifiers in eleven models, ranging from 100 to 15,000 watt capacity.



Full wave electronic tube rectifier.

These rectifiers are designed for use in electroplating, battery charging and other uses where DC current is required. The rectifier units contain two high-capacity single plate tubes, one for each half cycle, with a 2000 hour guarantee. The tubes are housed in a cabinet unit designed for wall mounting and a hinged cover is provided for accessibility in replacing tubes.

Installation is simply made inasmuch as a terminal strip is provided for the connecting AC input and DC output lines. On the door of the cabinet is mounted an "off" and "on" switch for controlling the operation of the rectifier and an indicating light is provided to show when the unit is in operation.

The rectifiers are now available in the following capacities: 100, 250, 500, 750, 1200, 1500, 2000, 3000, 5000, 10,000, and 15,000 watts.

INDIUM

provides for...

Decorative Design

a permanent, continuous surface capable of high polish, resistant to discoloration....



Functional Design

a hard, nonporous surface resistant to wear, abrasion, corrosion and fatigue....

TODAY Write for complete information: how INDIUM can solve your design or construction problem.



THE INDIUM CORPORATION OF AMERICA

Research and Development Office
60 East 42nd Street, N. Y. C.

Please send _____ grams of INDIUM for experimental use at \$1.00 per gram. Check or money order attached.
Please send me informative literature about INDIUM.

Name _____

Address _____

THE INDIUM CORPORATION OF AMERICA

Research and Development Office
60 East 42nd Street, N. Y. C.

Sales Office and Laboratory
805 Watson Place, Utica, N. Y.

Manufacturers' Literature

Cement for Abrasives

J. J. Siefen Co., 5657 Lauderdale, Detroit, Mich., have just issued a 24-page booklet entitled, "Nuglu-Liquid Cold Glue," an adhesive which is recommended for setting up polishing wheels, belts and discs. The material has sodium silicate as a base to which has been added various materials to improve its adhesive and working properties. The material is available in more than 30 grades to suit different types of work. The book contains a description of the adhesive and complete information on the use of the adhesive. This includes preparation of the wheel, drying, breaking-in and balance. Valuable advice on using the wheel and various other information is given. Causes of failure of polishing wheels are also outlined. Other products of the company, such as rectifiers, cleaners and buffs are described.

Cleaning Shells

In view of defense demands for greatly accelerated output of munitions, a 5-page, illustrated feature article appearing in the November-December, 1941 issue of *Oakite News Service*, house magazine of Oakite Products, Inc., New York, is of timely interest since it describes how new cleaning materials and methods are successfully helping speed-up shell production.

The article gives considerable data on cleaning high explosive, anti-aircraft and howitzer shells ranging in size from 75-mm. to 155-mm. before inspection and painting either by mechanical washing machine or tank cleaning methods. In this connection, the characteristics and qualities required of materials used in this work are also reviewed.

Among the important, closely related factors discussed which influence production quality and output of shells, are the effect of drawing lubricants and cutting fluids on subsequent cleaning operations, the simplification of cleaning through new production techniques, and prevention of rust formation on steel shells after cleaning.

Another article appearing in this issue of *Oakite News Service* describes and illustrates the plating of aluminum, brass and Invar metal radio condenser parts to micrometer tolerances.

Copies of this issue of *Oakite News Service* are available upon request. Write to Oakite Products, Inc., 18 Thames Street, New York, N. Y.

Coal Tar Products

Koppers Co., Tar and Chemical Division, Pittsburgh, Pa., have just issued an 8-page folder which summarizes all of Koppers' important products, plants and services. The list ranges from Koppers coals and coke to light oil plants and purification systems; from valves, castings, forgings, couplings and piston rings to roofing,

LOOK AT THIS



1 Troy Ounce
Contains 31.103 Grams

AND THEN AT THIS



1 Avoir. Ounce
Contains 28.35 Grams

ROBINSON'S ASSAYED GOLD PLATING SOLUTION IS SOLD BY TROY WEIGHT

Each Ounce Contains 31.103 Grams of Pure Gold



NOT 40%

NOT 60%

NOT 80%

BUT—100%

ALWAYS

Base your comparative cost calculation on the above when buying prepared gold for plating.

MADE BY

A. ROBINSON & SON

FOUNDED 1879

131 Canal Street, New York.

Tel. CA 6-0310 - 6-0464

Assayers, refiners and smelters of any scrap or waste containing

PRECIOUS METALS

Full returns on rolled-gold scrap, used gold plating copper wires, discarded gold plating solutions, gold-leaf skewings, mercury.

Distributors of

The Johnson-Matthey & Co. Inc. Well-Known Rhodium Plating Solution

IS THE DAY TOO SHORT?

Save Time By Sending Your Solutions To Us For Analysis.
Immediate Accurate Report By Air Mail.

NICKEL SOLUTIONS
Nickel, Chlorides
Boric Acid, pH
COPPER SOLUTIONS
Copper, Free Cyanide
Carbonates, pH
ACID COPPER
Copper, Sulfuric Acid

\$1

ROCHELLE COPPER
Copper, Rochelle salts
Free Cyanide,
Carbonate, pH
BRASS SOLUTION
Copper, Zinc, pH
Free Cyanide,
Carbonate

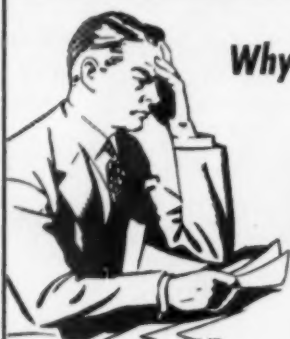
\$1.50

Other Solutions & Other Ingredients At Equally Low Prices
Send a 4 oz. Bottle by Parcel Post or Prepaid Express

KOCOUR CO.

4724 S. CHRISTIANA AVE. • CHICAGO

★ ★ ★ SPECIALISTS IN SOLUTION CONTROL ★ ★ ★



**Why Worry About Metal Shortages
When You Can Use**

EBONOL

Reg. U. S. Patent Office

THE JET BLACK CORROSION RESISTANT FINISH FOR IRON AND STEEL

Check These Features:

- ✓ Fast Blackening by Immersion in Only ONE Bath
- ✓ Deep Penetration — No Red Stains
- ✓ Highest Corrosion Resistance
- ✓ Simple and Economical to Operate

We are confident that EBONOL is the outstanding blackening process for iron and steel and all we want is an opportunity to prove this to you. Hundreds of parts now being made of brass, aluminum, or zinc and lacquered, enameled or plated, can be advantageously made of EBONOLIZED STEEL. Haircurlers, trunk hardware, guns, fan parts, pencil parts, tools, toys, bearing races, electrical apparatus, electrical appliances, switch parts, clock parts, pins, lamps, drapery hardware . . .

LET OUR FINISHING ENGINEERS SERVE YOU

Send sample parts for finishing or tell us your problem

The **ENTHONE Co.**
New Haven, Conn.

Specialists Since 1930 in Finishing Materials and Processes

tar-base paints and pressure-treated timber products. Two pages are devoted to the uses, technical description and characteristics of tar acids, tar acid oils and coal tar solvents.

Corrosion Resistant Chemical Equipment

Haveg Corp., 28 Chapel St., Newark, Del., have recently published an 8-page catalog describing their corrosion resistant chemical equipment. This equipment is molded from a mixture of a special acid-washed asbestos and a synthetic phenol-formaldehyde resin. Equipment in standard tanks, towers, fume ducts, pipes, fittings and valves is available on a reasonable delivery basis. In April 1941, the company's plant capacity was doubled and additional changes are now underway to increase it. Photographs illustrate the installation of the various equipment, and specifications are given on the same.

Hypressure Steam Cleaners

Homestead Valve Mfg. Co., Coraopolis, Pa., have recently published a catalog describing and illustrating their "Hypressure Jenny" steam cleaner. Various uses for the cleaner are illustrated and described. These include cleaning machinery, buildings, engine parts and walls. Other information given includes principles of operation, model specifications and information to aid in the selection of the equipment best suited for the customer's cleaning job.

Low Temperature Welding

Eutectic Welding Alloys, Inc., 40 Worth St., New York, have just issued a 32-page catalog describing low temperature welding employing the company's eutectic alloys and welding fluxes. These materials can be used with oxyacetylene torches, gas, furnace or arc heat, to effect easy welding at temperatures considerably lower than the melting point of the object being welded, or below temperatures that affect the physical properties of the metal being welded. Numerous illustrations show proper methods of joining metal and various typical applications are shown. The various alloys sold by the company with their

PERMAG Cleaning Compounds

—the Solution to your Cleaning Problems in National Defense Work

Eliminate faulty cleaning and all rejects by using the cleaner suited for your work. There's a PERMAG Cleaner made for every metal cleaning job. Shell cases, machine gun parts, air craft instruments and parts, and scores of other items used in defense work are cleaned by PERMAG. Let the Magnuson Research Service aid you in any cleaning difficulty. Write or 'phone.

MAGNUSON
PRODUCTS CORPORATION

Manufacturers of Special Cleaning Compounds for Industrial Purposes
Main Office, 50 Court St., Brooklyn. Factory, Brooklyn, N. Y.
Representatives from Coast to Coast. Warehouses in Principal Cities of U. S.
In Canada: Canadian PERMAG Products Ltd. Montreal and Toronto.

corresponding physical properties are described in detail. This valuable booklet will be sent free of charge to all readers upon request.

Portable Electric Tools

Independent Pneumatic Tool Co., 600 W. Jackson Blvd., Chicago, Ill., have issued a new 64-page catalog, describing their complete 1942 line of "Thor" portable electric tools. The book contains descriptions, specifications and prices on universal type electric drills, drill stands, screw drivers, grinders, sanders, polishers and electric tool accessories, etc. It is printed in two colors and profusely illustrated with photographs of tools in operation on various types of work. It contains information on the uses and construction of these tools. Also featured in this catalog, are the $\frac{1}{4}$ " and $\frac{1}{2}$ " capacity drills, the original small and light tools for fast drilling, and the new "Thor-Nado" electric hammer and nibbler for cutting metal. This catalog is available to industrial executives, production men and engineers upon request.

Sodium Orthosilicate

The Pennsylvania Salt Mfg. Co., 1000 Widener Bldg., Philadelphia, Pa., have recently published a folder giving useful information on the properties of "Orthosil", the company's sodium orthosilicate. The relative conductivity of Orthosil solutions and other common alkalies is compared. The available sodium oxide concentration of Orthosil as compared with various proprietary materials is graphically illustrated. Photographs depict various industrial applications of sodium orthosilicate including cleaning before painting, before plating, enameling and Bonderizing.

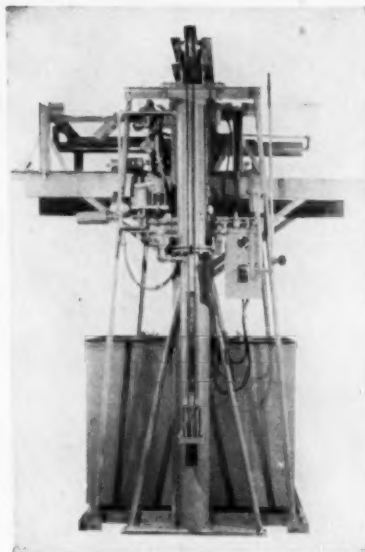
Temperature Control Systems for Fuel Fired Galvanizing Kettles

Brown Instrument Co., Wayne and Roberts Aves., Philadelphia, Pa., have just issued their new Bulletin No. 36-4, entitled "Brown Temperature Control Systems for Fuel Fired Galvanizing Kettles." This bulletin fully describes the three types of Brown automatic control systems recommended to operators of galvanizing kettles for all types of work. The systems are: proportioning temperature control for the continuous process, batch process and automatic reset for the continuous process. All descriptions contain a review of the principles of operation and types of instruments used for each system. Also included in the bulletin is a schematic diagram showing how the system is applied to the galvanizing kettle. A copy of this bulletin will be sent to any readers upon request.

New Books

Occupational Diseases. By Rutherford T. Johnstone, M.D. Published by W. B.

Crown Pick-up Unit



...MACHINE...

A UNIT TYPE TRANSFER CAPABLE OF HANDLING SEVERAL TANKS AT ONE TIME.

...USE...

FOR A SERIES OF OPERATIONS WHERE THE WORK MUST PASS THROUGH SEVERAL TANKS, AS THE CLEANING AND RINSING OPERATIONS, FOR A SEMI-AUTOMATIC PLATING TANK.

CROWN RHEOSTAT & SUPPLY CO.
1910 MAYPOLE AVENUE :: :: CHICAGO, ILLINOIS

DEFENSE FINISHING PROBLEMS

Our complete line of polishing and buffing compositions including greaseless compound and a laboratory with a technical staff experienced in the problems encountered in finishing defense materials, are at your service.

Upon request we will be pleased to submit samples or have a salesman call.

McALEER MANUFACTURING COMPANY

ROCHESTER

MICHIGAN

McALEER MANUFACTURING COMPANY, LTD.

WALKERVILLE

ONTARIO

BRANCH OFFICES

420 Lexington Ave., New York City

145-22nd Ave., San Francisco, Cal.

4014 W. Parker Ave., Chicago, Ill.

11 Scribner N. W., Grand Rapids, Mich.

1570 S. First St., Milwaukee, Wisconsin

Metso Cleaners Suspend Dirt



USERS of Metso Cleaners know they choose wisely, for they depend on Metso to remove dirt and also to keep it from reaffixing itself to the clean work.

Metso Cleaners suspend grease, oil and dirt, and prevent them from redepositing on the metal. This action is

a special function of silica (SiO_2) content of Metso. Electroplaters particularly welcome the chemically clean surface which Metso gives.

May we tell you more about the role of silica in Metso Cleaners and how it aids you in cleaning metals more efficiently?

PHILADELPHIA QUARTZ COMPANY

Gen'l Offices: 125 S. Third St., Phila., Pa. Chicago Sales Office: 205 W. Wacker Dr.
Sodium Metasilicate U. S. Pat. 1898707. Sodium Sesquiosilicate U. S. Pat. 1948730, U. S. Pat. 2145749

EST. 1831



METSO CLEANERS

When BEST it's FELT



Companies that make their product look worth the difference to the buyer use Paramount Brand Felt Polishing Wheels to polish the base metal, knowing that to have the best finish, you must start right, which means, Paramount Felt Polishing Wheels.

Ask Your Supplies Salesman
for PARAMOUNT BRAND

BACON FELT CO.

WINCHESTER
MASS.
ESTABLISHED
1824

Saunders Co., Philadelphia, Pa. Size 9½" x 6½"; 558 pages. Price \$7.50.

The fundamental aim of this book is to outline a basis for the diagnosis and treatment of the more common occupational diseases, to interpret the medicolegal phase and to offer from experience the expected disability.

The author is director of the Department of Occupational Diseases, Golden State Hospital, Los Angeles, Cal., and has a wealth of experience in the field. The main lack of knowledge of the average physician in regard to legal aspects of industrial injury is emphasized and three chapters are devoted to an extensive exposition of workmen's compensation, methods of evaluating disability and the function of the physician as related to workmen's compensation. Although written particularly for the physician, these chapters should be of considerable value to any engaged in employing or supervising help. Substances met with in industry which are most prevalent and most injurious to health have received comprehensive treatment. An important feature of the book is that treatment is given in detail rather than giving merely general details.

A portion of the book is devoted to gases, solvents and fumes, another to metals including lead, mercury, manganese, chromium, cadmium, selenium and vanadium, arsenic, zinc, antimony, copper and tin, and another section to the effects of dust. The industrial back, a very important consideration in industrial medicine, is given considerable treatment and the dermatoses of industry are discussed at some length. Other considerations are occupational cancer, electrical injuries, the medicolegal relationship of trauma to disease and pre-employment examination.

The book is well illustrated with excellent photographs of X-rays, cross-sectional photomicrographs (some of which are in color), drawings and charts. The treatment given to metals is particularly good, and the discussion of lead should be found most valuable.

This excellent and valuable publication should be in the hands of every employer, industrial physician and every physician who deals with industrial accidents.

Pyrometry. By Wm. P. Wood and J. M. Cork. Published by McGraw-Hill Book Co., Inc., New York. Size 9¼" x 6¼"; 257 pages. Price \$3.00.

This is the second edition of a book which was first published in 1927. In the period since the publication of the first edition, remarkable advances have been made in the production and measurement of extremely low temperatures and likewise the use of pyrometry equipment in the measurement and control of temperature in industrial processes, such as for annealing, heat treatment, baking and enameling.

The book opens with the discussion of the various temperature scales. Fluid thermometers, thermoelectric pyrometers, resistance thermometers, optical pyrometers and total radiation pyrometers are given thorough treatment.

An interesting chapter is that on transition points and thermo analysis with particular relation to metallurgical transition points. Refractory materials used in pyrometry are

given in the concluding chapter. The appendix contains valuable data, such as boiling points of materials for thermometric standardization, melting points of refractory materials and a temperature conversion table. Considerable data are included on temperature-potential relationships for various thermocouples.

A valuable book for engineers, metallurgists and chemists engaged in determinations of temperatures of processes and for a control of temperature.

Associations and Societies

Chicago Branch

Annual Educational Session and Dance

The annual educational session and dinner dance of the branch will be held on Saturday, January 31st, at the Palmer House, Wabash Ave. and Monroe St., Chicago, Ill. The educational session will start at 2:00 P. M. in the Club Building in the Palmer House, which is entered from the main lobby of the Palmer House.

The following educational program will be presented.

"A Short Report on the Metal Situation". By Dr. Wm. Blum (to be read by a member of the research committee).

"Unichrome Alkaline Copper". By T. Coyle, United Chromium, Inc.

"Uses of Black Oxide Coatings on Steel in the Present Emergency". By Dr. A. Kenneth Graham.

"Indium Finishes for Decorative and Functional Designs". By Dr. W. F. Murray, Indium Corporation of America.

"Some Plating Room Economies". By G. Hogaboom, Hanson-Van Winkle-Munning Company.

In the evening the dinner and dance as well as entertainment will be held in the Grand Ballroom of the Palmer House.

All tickets will be reserved and each ticket will entitle the holder to a place at a definite table. Seating assignment will be made according to the order of receipt of reservations. Price of ticket is \$4.50 per person. Reservations should be made to J. W. Hanlon, 3004 N. Whipple St., Chicago, Ill.

Grand Rapids Branch

5th Annual Educational Session and Banquet

The branch will hold its 5th annual banquet and educational session on Saturday, January 17 at the Pantlind Hotel in Grand Rapids.

The following lists the speakers and the respective subjects of their talks:

1. "Acid Copper Plating," by Walter L. Pinner, General Spring Bumper Div., Houdaille Hershey Corp., Detroit, Mich.

2. "Useful Applications of Bipolarity in Practical Plating," by Frank K. Savage, Electrochemical Engineer, C. G. Conn, Ltd., Elkhart, Ind.

SPEED UP
YOUR DEFENSE OUTPUT
WITH

**COWLES
CLEANERS**

Clean all metal surfaces

—QUICKER!

—BETTER!

—RIGHT THE FIRST TIME!

THE COWLES DETERGENT COMPANY
CLEVELAND, OHIO

Mail this coupon TODAY!

The Cowles Detergent Company, Metal Cleaner Department
7016 Euclid Ave., Cleveland, Ohio

What do you recommend for this type of cleaning? _____

Company _____

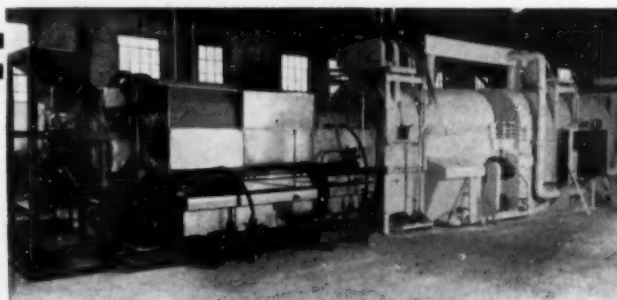
Street and No. _____

City and State _____

Signed _____

Title or Department _____

**MANY
MAN
HOURS**



SAVED FOR NATIONAL DEFENSE
by RANSOHOFF EQUIPMENT

The new Ransohoff Batch Finish Pickler, designed to speed up production, is satisfactorily meeting all demands in putting the final finish to .30 and .50 calibre cartridge cases. • The unit consists of three, patented, batch rolling or tumbling barrels in series; an acid roll, soap roll, and rinse and drying during discharge, all automatically controlled by master switch. • A Ransohoff Representative will help solve your cleaning and washing problem. Write Dept. "MR" today for Catalog.

N. RANSOHOFF, INC. TOWNSHIP AND BIG FOUR R.R. CINCINNATI, OHIO

Speed ACID PICKLING the DOUBLY SURE* Way with Enthone Acid Addition Agent



★ **FASTER PICKLING** — the acid rapidly penetrates under rust and scale, thus **LIFTING THEM OFF!**

★ **SAVES ACID** — Drag-out is materially reduced and acid is saved by inhibiting action.

OVERCOMES WATER-BREAK IN PICKLING — Due to poor alkaline cleaning or soap in the alkaline cleaner, water-breaks appear on acid dipping before plating. The use of **ENTHONE AAA** in the acid literally makes the acid a cleaner and overcomes peeling due to faulty cleaning.

Write today for **FREE Trial SAMPLE** and valuable informative **BULLETIN**

THE Enthone COMPANY
NEW HAVEN CONNECTICUT



PICKLING AND PLATING TANKS

TOUGH STRONG DURABLE



A MOLDED PHENOLIC RESIN ASBESTOS PLASTIC.

HIGHLY RESISTANT TO HOT ACIDS

One Piece Tanks
As large as 9'6" x 6'6".
Also Pipe . . . Fittings . . .
Valves . . . Fume Duct . . .
Towers . . . Standard Sizes or
Special Designs to Order.
Send for Bulletin F 28.

HAVEG CORP., NEWARK, DEL.

3. "Modern Organic Finishing Materials — Applicability, Availability and Testing," by *Dr. G. C. Given*, Fabrics and Finishes Div., E. I. duPont de Nemours & Co., Inc. Presiding officer, *Robert Wagner* of Guide Lamp Div. of General Motors Corp., Anderson, Ind.

The educational session will start at 1:30 P.M. In the evening an informal dinner will be held at 7:00 P.M., followed by a floor show and dancing. Romanoff's Orchestra will furnish the music.

For reservations, contact *C. O. Werft*, 1107 Powers, Grand Rapids, Mich. Price is \$3.00 per person. Reservations for the dinner dance should be made as soon as possible. There will be ten persons at a table.

Boston Branch

Annual Educational Session and Banquet

The Boston Branch will hold their annual meeting on March 28 at the Hotel Statler. The educational session will be held in the afternoon, and the usual excellent entertainment, dinner and dance in the evening.

Joe Barron, 143 Sidney St. Cambridge, Mass., is general chairman.

Annual National Convention of A.E.S.

The following is the General Committee for the annual meeting of the supreme society, to be held in Grand Rapids, June 8-11, 1942:

General Chairman: *Chester W. Smith*, 600 Prospect S.E., Grand Rapids, Mich.

Educational: *L. B. Sperry*, 321 Carlton S.E., Grand Rapids, Mich.

Financial Secretary: *Homer G. Morton*, 2615 Albert Dr., S.E., Grand Rapids, Mich.

Program and Publicity: *F. D. Pace*, 134 Grandville S.W., Grand Rapids, Mich.

Advisory: *Maurice R. Caldwell*, 1501 Paris S.E., Grand Rapids, Mich.

Housing Chairman: *Clyde Craven*, 127 Wallinwood N.E., Grand Rapids, Mich.

Recreation: *Jack J. Hanney*, 1109 Hoyt S.E., Grand Rapids, Mich.

Plant Visitation: *Ivan C. Hepfer*, 1255 Orville S.E., Grand Rapids, Mich.

Registration: *Charles O. Werft*, 1107 Powers N.W., Grand Rapids, Mich.

Entertainment: *Stewart Z. Martin*, 101 Quimby N.E., Grand Rapids, Mich.

Transportation: *C. E. Abel*, 1150 Louis N.W., Grand Rapids, Mich.

Exhibits: *C. Fernekes*, 2020 College S.E., Grand Rapids, Mich.

In spite of the war, there is no thought of abandoning the idea of holding a convention for 1942, and the committee is working hard to make the program highly successful.

T. A. Trumbour of Metal Finishing, recently concluded an inspection trip of the facilities for the convention at Grand Rapids, and said, "After looking over the facilities for the convention at Grand Rapids, I am certain that they are ample and excellent for holding the various functions of the society, including the International Fellowship Club Open House Party, educational sessions and

closing banquet and dance. I was impressed by the enthusiasm of every member of the committee and feel certain that the meeting will rank with Boston and other past successful conventions."

Los Angeles Branch

The date for Los Angeles Branch's 1942 educational session has been set for March 21, with the Los Angeles Breakfast Club as the scene of the business meetings and the products exposition. Preliminary details were discussed at a meeting of the committee at the home of Chairman *Marcus Rynkofs* in December. Associate committeemen are *Don Bedwell*, *James ApRoberts*, *Frank Bunker*, *Stanley Rynkofs*, *Ed Wells* and *Erwin Fraunhoffer*. The committee decided to confine the speakers' program to six papers, with subjects of papers and names of speakers to be decided upon later.

Obituaries

Walter J. Shaw

Walter J. Shaw, retired, died at his Los Angeles home on December 10 at the age of 75. He was the father of Frank Shaw, Sr., grandfather of Frank Shaw, Jr., and father-in-law of Frank Merigold, all members of Los Angeles Branch, A.E.S. The funeral was at Los Angeles December 12.

W. J. Reardon

W. J. Reardon, former metallurgical editor of Metal Industry (now Metal Finishing) died in Detroit, Mich., on December 24 at the age of 71.

Mr. Reardon was born in Paterson, N. J., and joined the Westinghouse Electric & Mfg. Co., in 1903, and was sent to Europe to introduce American foundry methods in the company's plants there. He was in charge of the Rome Mfg. Company's foundry at Rome, N. Y., from 1919 to 1921, and then founded the National Alloys Co. of



W. J. Reardon

ATTENTION

Manufacturers with defense contracts

Manufacturers already in production on defense contracts are using Wyandotte Metal Cleaners especially adapted to their many problems.

INVESTIGATE OUR SPECIAL CLEANERS—

1. For cleaning pistons, crankshafts, camshafts, valve stems, rings, etc., prior to Lubrite Process of Parker-Rustproof Company.
2. For cleaning brass cartridge cases, all sizes, after drawing and machining.
3. For cleaning steel projectiles, all sizes, after machining and prior to painting and lacquering.
4. For cleaning bomb bodies prior to painting and lacquering.
5. For cleaning bomb fins, fin assemblies, and similar steel stampings prior to painting or lacquering.
6. For cleaning fuses and fuse bodies (aluminum or brass) after machining.
7. For cleaning steel fuse parts and boosters prior to cadmium plating.
8. For process cleaning of airplane motor parts (aluminum and magnesium).
9. For cleaning before heat treating.
10. For cleaning quenching oils after heat treating.
11. For cleaning sheet and cast aluminum prior to anodizing.

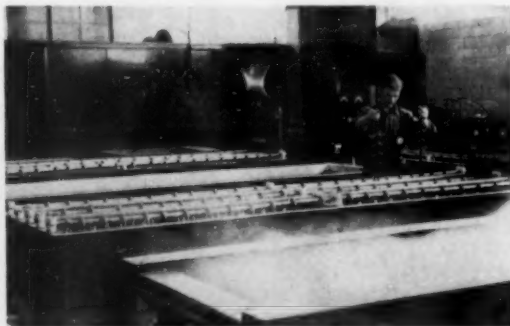
There is a Wyandotte Cleaner for any metal-cleaning problem and for use in all types of equipment.



SERVICE REPRESENTATIVES IN 88 CITIES

THE J. B. FORD SALES CO. • WYANDOTTE, MICHIGAN

TANKS BY THE 'HUNDRED'S for DEFENSE



Typical Heil Tanks in Aviation

LEAD — RUBBER — CERAMIC — PLASTIC LININGS
STEAM COILS AND JETS, GAS, ELECTRIC HEATERS

HEIL & COMPANY

12901 ELMWOOD AVE.

CLEVELAND, O.

PROCESSES

ANODIZING

ALUMILITE

BLACK COLOR CHROME

PICKLING

PLATING

**Trouble
Getting Chlorinated
Solvents?**

**Here's a better
and Cheaper Method
for Metal Degreasing!**

The Magnus Emulso-Dip or Emulso-Spray method of cleaning metal parts solves the problem completely:

- It replaces solvent or vapor degreasing.
- Does a quicker, better, more thorough job—at lower cost.
- Handles smut and difficult dirt not readily removed by other methods.
- Can be used without heat on many operations.
- Is applicable to all types of metal cleaning.
- Has been successfully used for months in many defense plants.

Get the complete story now. Emulso-Dip or Emulso-Spray can save you time and money and insure speedy production of your vital war orders.

MAGNUS CHEMICAL COMPANY, Inc.

Manufacturers of Cleaning Materials, Industrial Soaps, Metallic Soaps, Sulfonated Oils, Emulsifying Agents and Metal Working Lubricants.

MAGNUS EMULSO-DIP

MAGNUS EMULSO-SPRAY

Two variations of same new metal cleaning method.

Adaptable in many cases to existing washing machines.

If not, we will design and build Magnus Emulso-Dip or Emulso-Spray washing machines to meet your particular problems

**USE
THIS
COUPON**

MAGNUS CHEMICAL COMPANY, INC., 11 South Avenue, Garwood, N. J.
Send us:
☐ Emulso-Dip Bulletin ☐ Proposition { Machine conversion
New Emulso-Dip or Spray Machine
Name.....Title.....
Company.....
Street.....
City.....State.....

Detroit, which he headed until his death. He was also superintendent of the Detroit foundry of the Aluminum Co. of America. His contributions to the technical literature were many and he was widely known in the foundry field.

He was buried in Holy Sepulchre Cemetery, Paterson, N. J. Surviving are his wife, Agnes L. Reardon, and a son, William F. Reardon, vice-president of the National Alloys Co.

Mrs. Elizabeth Lamoureux

Mrs. Elizabeth Lamoureux, wife of Ernest Lamoureux of Los Angeles Branch, A.E.S., died at her Los Angeles home, 207 South Reno St., December 4th, at the age of 73. Death was due to a heart attack.

Mrs. Lamoureux had been ailing for several years. For the past 1½ years, she had found it necessary to withdraw almost completely from the activities of Los Angeles Branch members with whom she had been closely associated since 1929. Her last public appearances at any of the branch functions were the 1940 annual banquet and picnic.

The funeral was Monday, December 8, with services held at 10 a.m. in the Church of the Precious Blood in Los Angeles. Interment was in Calvary Cemetery, Los Angeles.

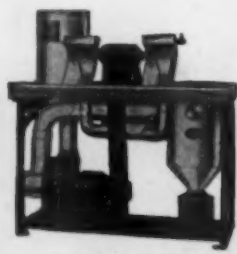
Six members of Los Angeles Branch, some of whom had been friends of the Lamoureux' since the early years of the century in the middle-west, served as pallbearers. They were Don M. Bedwell, Marcus D. Rynkofs, Clarence E. Thornton, John Merigold, E. W. Francis and Earl Coffin.

The Lamoureux' were married 48 years ago in Piqua, O., where Mr. Lamoureux had been connected with the plating department of the Favorite Stove and Range Co. They lived subsequently in Sidney, Columbus and Dayton, O., and Chicago, Ill. In 1929 she came to Los Angeles with her husband when he retired after 23 years of service as sales representative for Hanson-Van Winkle-Munning Co. and its predecessors.

Mrs. Lamoureux had a wide acquaintance in A.E.S. circles throughout the country. Until she and Mr. Lamoureux took up residence in Los Angeles in 1929 she had attended with him every annual convention of the supreme society.



Blower



Polishing Bench



Dryer



Tubbing



Sawdust Box



Sandblast

THE BOLAND SYSTEMS FOR FACTORY INSTALLATIONS

H. J. ASTLE CO., & INC. Established 1884 (Send for Catalogs) 118 Orange St., Providence, Rhode Island

Personals

Eaton Appointed Engineer of G-E Bridgeport Laboratory

Irving C. Eaton, assistant engineer of the General Electric works laboratory at Bridgeport, Conn., since 1930, has been appointed engineer by W. Stewart Clark, works manager, succeeding E. W. Schwartz who has resigned.

A graduate of Massachusetts Institute of Technology in 1917, Mr. Eaton has for many years been engaged in technical and executive positions in the chemical and



Irving C. Eaton

electrical industries. He was at one time assistant to the superintendent of the Union Carbide Company of Canada Ltd., at Wel-land, Ontario; assistant superintendent of Bird and Son Inc., of Phillipsdale, R. I.; and works manager of the sheet division of the Fiberloid Corp., now Monsanto Chemical Co., at Indian Orchard, Mass., prior to his connection with General Elec-tric. A member of the American Chemical Society, he is vice president of the Bridge-port Engineering Institute in charge of the department of chemistry and metallurgy.

Beitzel Becomes a Vice-Pres. of Penn Salt

The Pennsylvania Salt Manufacturing Company of Philadelphia announces the promotion of George B. Beitzel from Man-ager of Sales to Vice President in charge of sales. Mr. Beitzel's elevation to this important position will be of interest to users of metal cleaning compounds of the type manufactured by his company. Prim-arily a manufacturer of products derived from salt, the company, about seven years ago, decided to develop its sub-silicate products for use in metal cleaning. Mr. Beitzel has been largely instrumental in the promotion of the company's cleaning prod-ucts to their present position of importance both in the industry and in the company's business.

CHROMIC ACID

99.75% PURE

With two complete, independent plants at Jersey City and Baltimore, and its own supply of the basic raw material Chrome Ore from company owned and operated mines, Mutual is the world's foremost manu-facturer of Chromic Acid.

BICHROMATE OF SODA

BICHROMATE OF POTASH

Mutual Chemical Co. of America

270 MADISON AVENUE, NEW YORK



4-MAX



Serving You....

- ★ RUBBING COMPOUNDS
- ★ LIQUID POLISHES
- ★ DRAWING COMPOUNDS
- ★ POLISHING AND BUFFING COMPOSITIONS

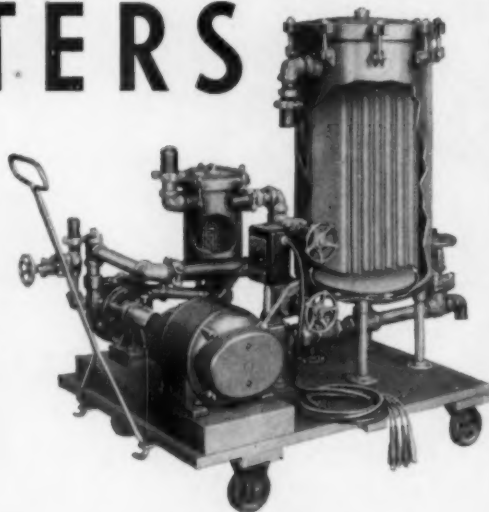
We've got a free sample of our No. 750 Copper Buffing Composition for you. It's a honey! Send for it today.

• FORMAX MFG. CO., 3999 18th St., DETROIT, MICH. •

FILTERS

For

Bright Nickel
Nickel
Chrome
Copper Sulphate
Cyanide Copper
Brass and Zinc
Cadmium
High Speed Copper
Britz Zinc
Silver
Electrocolor
And Others



INDUSTRIAL FILTERS will do a fine job of filtering and purifying your plating solutions, at the lowest possible cost per filtered gallon.

INDUSTRIAL FILTERS have larger filter areas, more sludge holding capacity and higher pressure pumps, which insure high flow rates and longer filter cycles. The "LEAK-PROOF", "CORROSION-PROOF" and non-contaminating construction of Industrial Filters is a vital requisite of Electroplating filters.



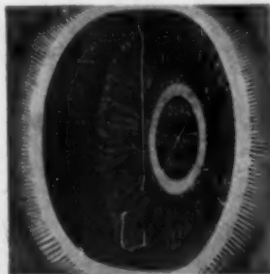
SALT SPRAY CORROSION TEST EQUIPMENT

For testing—Electroplated or coated metals at 95 deg. Fah. in accordance with Army, Navy and Aeronautical specifications, as outlined in Bulletin AN-QQ-S-91-5 dated Dec. 1936. Also for controlled temperatures at any degree. Testing Cabinets lined throughout with rubber. Made in 4 sizes.

"Write for NEW Literature and particulars."

INDUSTRIAL FILTER & PUMP MFG. CO.
3017 WEST CARROLL AVENUE CHICAGO, ILLINOIS

A new type WHEEL FOR POLISHING & GRINDING in four materials



1. leather
2. canvas
3. cotton
4. wool

We guarantee better results, lower cost per piece polished or ground, prompt deliveries. Advise us material to be polished or ground, diameter, width of wheel and arbor hole. We will give you the proper wheel for your work.

ARROW DURAWHEEL, INC.

60 GRAND STREET

WO 4-8870

NEW YORK, N. Y.

George Beitzel's career is an example of the success which can come from hard work and steady and unflagging perseverance. He was educated in the public schools of Philadelphia and at the University of Pennsylvania. He served his country in the First World War, advancing through the ranks from private to first lieutenant. After the War he spent a number of years with John T. Lewis & Bros. Company, paint manufacturers, and twelve years ago went to the Pennsylvania Salt Manufacturing Company.

George Beitzel's high standing in the field of sales management is attested by the fact that he is now President of the Sales Managers' Association of Philadelphia.

Alexander Gobus, metallurgist, Lucius Pitkin, Inc., 47 Fulton St., New York, was recently elected vice-chairman of the New York Chapter of the American Society for Metals.

Business Items

Nickel Salts Available

Harshaw Chemical Co. of New York, Inc., Chrysler Bldg., New York, have recently informed METAL FINISHING that the company states that any legitimate consumer of nickel sulphate who can prove that he requires this material for prompt consumption can secure the same from the Harshaw Chemical Co., at the scheduled price of 13½¢ per lb. delivered.

This statement was made in view of the fact that second-hand chemical dealers in the New York market are asking premium prices for nickel sulphate.

E. F. Houghton & Co. Open New Plant

To mark the completion of its new, ultra-modern office building, E. F. Houghton & Co., manufacturers of oils, leathers and metal working products, Philadelphia, held "open house" for stockholders and customers on Thursday afternoon, December 11.

This three-story structure, combining all modern features, including glass-block construction and air conditioning, was erected at Third, Orianna and Lehigh Avenue, adjoining the company's plant. Its completion, according to announcement made by Major A. E. Carpenter, President, represents only a part of the company's expansion program to take care of added direct and indirect defense work.

Added facilities to increase production of leather packings, made necessary by great growth of hydraulic controls in aircraft and machine tools, have also been provided in recent months. Enlarged shipping facilities and an increase in its carburizer and oil department have also been effected in an effort to keep pace with the demand for cutting, quenching and lubricating oils, heat treating and metal working products so urgently needed in the present emergency.

Manufacturing facilities of Luman Screw Products Co., formerly at 5903 East Florence Ave., Maywood, Calif., are enlarged

by some 2,500 square feet in the firm's new plant, 4340 East Slauson Ave., Maywood, into which operations were moved in December.

The Quality Jewelry Polishing Co. has been established at 220 West Fifth St., Los Angeles, by Irving Librach.

New incorporations in Southern California:

Metals Engineering Production Corp., Los Angeles. Directors: K. H. Grayson, E. H. Roth and L. A. Wittliff.

Metals & Manufacturing, Inc., by A. L. Knorr, 1976 Laura Ave., Huntington Park, Calif.

Johnson Bronze Co., a Pennsylvania Corp., Joseph C. Cannon, Los Angeles representative.

General Carbon Co., 512 S. Anderson St., Los Angeles, has construction under way in Huntington Park, Calif., on a new factory building for the manufacture of activated carbon and lamp black.

Pacific Solvents Co., Los Angeles, is erecting a new factory building at 1522 Fishburn St., containing 7,000 square feet of manufacturing area.

H. Elvin Beall, Supervisor Plating Shop No. 31 A. & R. Dept., Naval Air Station, Jacksonville, Fla., wishes to be placed on the mailing list for literature of manufacturers of equipment for plating, polishing, sand-blasting and metallizing as well as companies manufacturing lacquers and other organic finishing materials.

Adel Precision Products Corp., manufacturers of airplane accessories, broke ground in December for a \$200,000 addition to its Burbank, Calif., plant, which will increase its productive area by more than 118%. New precision equipment, machine tools and metal finishing, plating and polishing equipment now on order will entail an investment of another \$200,000, according to Ray Ellingwood, president.

Acme Electric Welder Co., 2618 Fruitland Road, Los Angeles, has completed an 18,000 sq. ft. modern factory of steel and brick. New machinery has been installed to allow straight-line production of electric spot welders.

Kunkel Metal Products, Inc., has been organized at Los Angeles by Robert S. Smith, R. H. Hamilton and A. F. Wilson.

Fulghum & Co., 2309 East 15th St., Los Angeles, is erecting a plant addition in which to expand production of lacquer and shellac.

Central Welding & Mfg. Co., 130 East Jefferson Blvd., Los Angeles, has completed plans for an addition of 3,700 square feet to its plant. The firm manufactures electric welders and pump units.

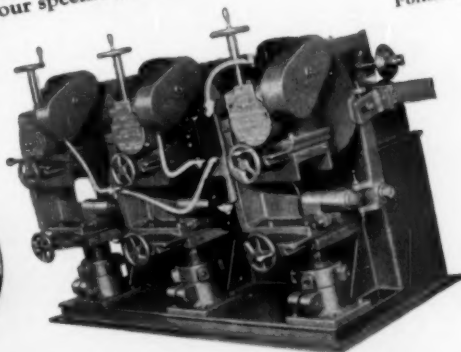
Dura Steel Products Co., 1774 East 21st St., Los Angeles, is erecting an addition to its plant for production of utility cabinets, coolers, mail boxes and sheet metal plumbing items.

The ACME METHOD OF Tube and Pipe POLISHING

✓ INCREASES PRODUCTION
✓ INSURES BETTER FINISH
✓ at Lower Cost

Polishing costs take a licking all along the line when this Acme 3-Wheel Automatic bites into a tough job of tube or pipe finishing. It gives a three-way savings by performing three operations in one pass through the machine. Adjustable feed speeds from 0 to 20 or more feet per minute and compensating adjustments for tube size and wheel wear meet every production and finish requirement. Investigate the advantages the Acme Method has to offer you on an application to meet your specific problem. Write Acme—no obligation.

Type T-3
3-Wheel Automatic
Polishing Machine



ACME Manufacturing Co.

1642 HOWARD ST. • DETROIT, MICH.
Builders OF AUTOMATIC POLISHING AND BUFFING MACHINES FOR OVER 25 YEARS

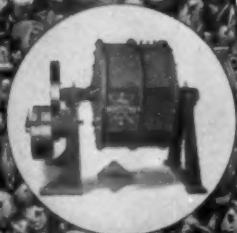
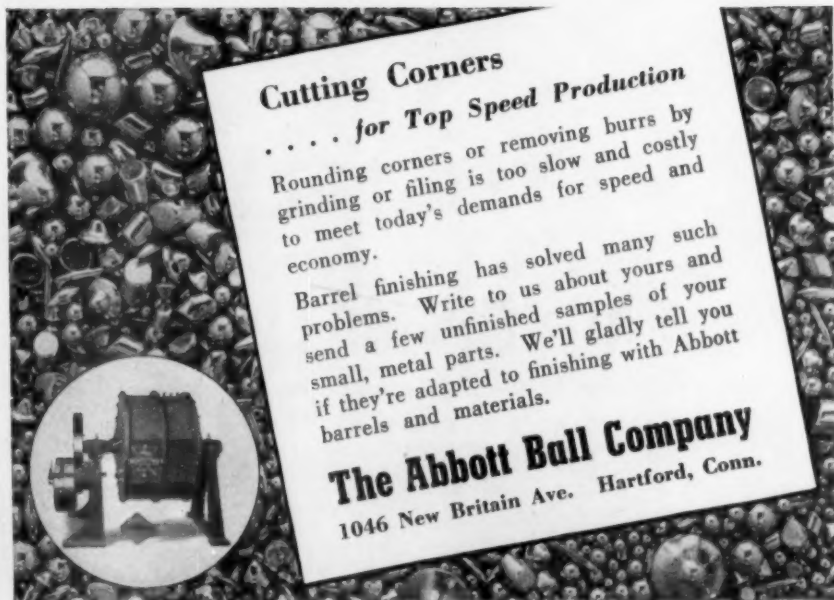
Cutting Corners ... for Top Speed Production

Rounding corners or removing burrs by grinding or filing is too slow and costly to meet today's demands for speed and economy.

Barrel finishing has solved many such problems. Write to us about yours and send a few unfinished samples of your small, metal parts. We'll gladly tell you if they're adapted to finishing with Abbott barrels and materials.

The Abbott Ball Company

1046 New Britain Ave. Hartford, Conn.



Advance Furniture Mfg. Co., manufacturer of wood and metal bedroom furniture, has moved from 2421 Santa Fe Ave., Vernon, Calif., to 725 East 59th St., Vernon, where 65,000 square feet of floor space are available for enlarged production.

Rite Hardware Mfg. Co. in December moved from 502 Douillard St., Los Angeles, to 532 W. Chevy Chase Drive, Glendale, Calif., where it has available increased plant facilities and floor area for the production of builders' hardware.

Arthur W. L'Hommedieu, president of *Chas. F. L'Hommedieu & Sons Co.*, Chicago, and *Mrs. L'Hommedieu*, arrived in Los Angeles for a two weeks' business and pleasure visit on December 6. They made the trip by automobile. Mr. L'Hommedieu conferred in Los Angeles with *Clarence E. Thornton*, Southern California manager of the firm.

Courses Offered to Aid Workers in Defense Industries

Courses in Electroplating

The Institute of Electrochemistry and Metallurgy, 59-61 East Fourth Street, New York City, will offer specialized courses in the field of electroplating and metallurgy during the Spring of 1942. Registration will be held for the Spring courses from February 9 to February 13th inclusive and the first class meeting will occur on February 10th. The following studies will be offered:

ELECTROPLATING II.

This course is designed to give the electroplater a knowledge of the ways and means of obtaining better deposits by applying the latest scientific methods of electrochemistry to electroplating. One hour of each evening will be devoted to a lecture on the theoretical aspects of the subject and two and one half hours will be spent in the laboratory where the student will apply the principles set forth in the lecture. Copper, nickel, zinc, cadmium, chromium, silver, and brass will be deposited from aqueous solutions. While plating the above metals, the factors governing the character of the deposit such as current density, temperature, pH, etc. will be noted. Other experiments will include throwing power, single electrode potential, addition agents, resistance of solutions, anodizing and coloring aluminum, corrosion tests, etc. After these are complete the student will prepare standard solutions and make analyses of all the important constituents of the above plating baths. Tuesday and Wednesday, 7:30 - 11:00 P. M. Prerequisite: Electroplating I. or its equivalent. Dr. Young and Mr. Klinseich. Fee \$45.00.

METALLURGY II. (Metallography):

This course is designed to teach the student preparation of metallographic samples for microscopic examination. Various samples of different metals and alloys will be polished, etched, and examined under the microscope. The detection of faulty alloys and metals will be stressed. Dr. Young and Mr.

Klinseich. Tuesday and Wednesday, 7:30 - 11:00 P. M. Fee \$25.00.

RESEARCH II.

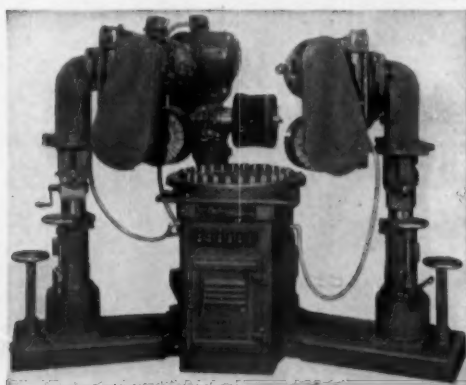
This course is designed to give the practical electrochemist a chance to investigate problems in his field. One half hour per week is devoted to a conference with the instructor in which the method of attack is laid out. The remaining time is spent in the laboratory where the student applies his knowledge and technique to the solving of problems which arise in such an investigation. Tuesday and Wednesday, 7:00 - 11:00 P. M. Dr. Young. Fee \$30.00.

INDUSTRIAL MICROSCOPY IIA:

This course is specially planned in photomicrographical analysis, general microscopy, and instruction on the metallographic microscope. Subjects covered include the preparation of materials and the proper selection of optical equipment, methods of illumination, control of glare, illumination by incident light, and the use of color filters, special methods of particle-size determination, determination of refractive index, micrometry, and the proper use of mounting media with respect to their relative refractive indices. Work with the polarizing microscope may also be arranged. Mr. Shillaber. Tuition and laboratory fees, \$55.00. Hours to be arranged and announced later.

Time payments may be arranged if desired. For further information call Dr. C. B. F. Young, ORchard 4-1778 or FLushing 9-1685.

POLISHING AND BUFFING



No. 424 Continuous Rotary Type

• AUTOMATICALLY
Production Increased with
PACKER-MATIC

Today's Efficient Method of Volume Finishing

• AUTOMATIC POLISHING & BUFFING MACHINES
Packer-Matic
THE PACKER MACHINE CO., MERIDEN, CONN., U. S. A.

METAL COLORING AND FINISHING

Hugo Krause

Consulting Chemist to Metal Finishing Industry

\$5.00

TELLS HOW . . .

- To color all types of metals and alloys
- To prepare metal surfaces for coloring
- To finish colored metals

It is comprehensive and will be of use as a reference and guide book to those engaged in metal coloring in its decorative as well as protective phases. Many of the so-called secret process of the electroplating art are described in considerable detail with critical comments by the author.

WHAT THIS BOOK CONTAINS

Formulae and Patents
Influence of Alloying on
Coloring
Difficulties Encountered
Preparation of Surfaces
Degreasing
Rust Removal
Grinding
Polishing
Cleaning
Lacquering
Waxing
Electrochemical Methods
Dipping
Rubbing and Contacting
Methods
Nickel
Copper
Silver
Brass
Cadmium
German Silver
Aluminum

Magnesium
Varnishes
Metal Lacquers
Bronze Powders
Antiquing Imitation
Platinum Finish
Coloring and Protecting Iron
Brass Zinc
Tin Silver
Gold
Platinum Plating
Precipitating Antimony
Arsenic and Bismuth
Bibliography
Cathodic Treatments
Anodic Metal Coloring
Protective Coats
Green Plating
Chemical Metal Coloring
Tempering
Burnishing
Phosphatizing Rust Prevention

Book Payable In Advance

Metal Industry, 116 John St., New York

METAL FINISHING, January, 1942

Supply Prices, December 26, 1941

Anodes

Prices are f.o.b. shipping point on quantities of from 500-999 lbs. for copper, brass and zinc. For nickel, prices are for quantities from 500-2,999 lbs.

COPPER: Cast, elliptical, 15" and longer	25½c. per lb.	ZINC: Cast, 99.99, 16" and over	16¼c. per lb.
Electrolytic, full size, 22½c.; cut to size	22½c. per lb.	NICKEL: 95-97 cast, elliptical 46c. per lb., 99% plus	
Rolled, oval, straight 15" and longer 23¼c. per lb.; curved	24¼c. per lb.	cast 47c.; rolled, depolarized	48c. per lb.
BRASS: Cast, 80-20, elliptical, 15" and longer	23½c. per lb.	SILVER: Rolled, .999 fine per Troy oz.	38c. per oz.

Chemicals

These are manufacturers' quantity prices and based on delivery from New York City.

Acetone, C.P., drums, l.c.l.	lb.	.09	Hydrogen Peroxide, 100 volume, carboys	lb.	.16-.18½
Acid, Boric tech., 99.5% gran., bbls.	lb.	.0615	Iron Sulphate (Copperas), cryst., bbls., 1-4 wks.	lb.	.02
Chromic, 99%, 100 lb. drums, l.c.l.	lb.	.18¼	Lead, Acetate (Sugar of Lead), crystals, bbls.	lb.	.12½
Hydrochloric (muriatic) tech., 20°, carboys, wks.	lb.	.0270	Oxide (Litharge), com., powdered, bbls.	lb.	.08¼
Hydrochloric, C.P., 20°, bottles	lb.	.19	Magnesium Sulphate (Epsom Salts), tech., bbls.	lb.	.018
Hydrofluoric, 30% bbls.	lb.	.06-.06½	Mercury Bichloride (Corrosive Sublimate), crys.	lb.	\$2.39
Nitric, 36°, carboys 1-9, wks.	lb.	.0595	Mercuric Oxide, tech., red, powder, bbls.	lb.	\$3.11
Nitric, 42°, carboys 1-9, wks.	lb.	.0745	Nickel, Carbonate, dry, bbls.	lb.	.36-.36½
Oleic (Red Oil), distilled, drums	lb.	.12-.13	Chloride, bbls.	lb.	.18-.20
Oxalic, bbls. l.c.l.	lb.	.14½	Salts, single, 425 lb. bbls.	lb.	.135-.145
Stearic, distilled, double pressed, bags	lb.	.14¼-.15¼	Salts, double, 425 lb. bbls.	lb.	.135-.145
single pressed, bags	lb.	.13¼-.14¼	Paraffin, refined, bgs., 123-125 a.m.p., c.l.	lb.	.0520
triple pressed, bags	lb.	.17-.18	Perchloroethylene, drums, l.c.l.	lb.	.08½
Sulphuric, 66°, carboys 1-9, wks.	lb.	.0245	Phosphorus, red, cases	lb.	.44
Alcohol, Amyl (Fusel oil, ref'd), l.c.l., drums	lb.	.17½-.19½	yellow, cases	lb.	.23-.25
Butyl-normal, l.c.l., drums	lb.	.11½-.15¼	Potash, Caustic, 88-92%, flake, drums, works, c.l.	lb.	.07
Denat., S.D. #1, 190 pf., 1-18 drms., wks.	gal.	.35½	Potassium, Bichromate, crystals, casks	lb.	.10
Diacetone, tech., drums, l.c.l.	lb.	.11½-.12½	Carbonate (potash) calc., wks., drums	lb.	.06¾
Methyl, (Methanol), 95%, drums, l.c.l.	gal.	.58½	Cyanide, 94-96%, dom. dms., wks.	lb.	.55
Propyl-Iso, 99%, drums, l.c.l.	gal.	.47	Pumice, ground, 1½ F. & coarser, bbls., wks.	lb.	.04½
Propyl-Normal, drums, wks.	gal.	.67-.70	Quicksilver (Mercury), dom. 76 lb. flasks, net	flask	\$212-\$215
Alum, ammonia, granular, bbls., works	lb.	.04	Rochelle Salts, crystals, bbls.	lb.	.44
Potash, granular, bbls., works	lb.	.0425	Rosin, gum, B, bbls., dock	lb.	.0352
Ammonia, aqua, 26°, carboys	lb.	.05¼	Silver, Chloride, dry, 50 oz. lots	oz.	.38¾
Ammonium, chloride (sal-ammoniac), white, granular, bbls., wks.	lb.	.0675	Cyanide, 100 oz. lots	oz.	.34
Sulphocyanide (thiocyanate), pure, crystal, kegs	lb.	.55	Nitrate, 100 oz. lots	oz.	.27¼
Sulphocyanide (thiocyanate), tech., kegs	lb.	.40	Sodium, Carb. (soda ash), light, 58%, bags	lb.	.0213
Antimony Chloride (butter of antimony), sol., carboys	lb.	.17	Cyanide, 96%, dom. 100 lb. drums	lb.	.15
Barium Carbonate, pptd., bags, l.c.l., works	lb.	.03	Hydroxide (caustic soda) 76%, flake, l.c.l.	lb.	.0490
Benzene (Benzol), 90%, drums, works	gal.	.20	Hyposulphite, crystals, bags, wks.	lb.	.0250
Butyl Lactate, drums	lb.	.235	Metasilicate, granular, 1-9 bbls.	lb.	.0335
Cadmium Oxide, l.c.l., bbls.	lb.	.95	Nitrate, rfd., gran., bbls., wks.	lb.	.029
Calcium Carbonate (Pptd. chalk), c.l., wks.	lb.	.02¾	Phosphate, tribasic, tech., bbls., wks.	lb.	.038
Carbon Bisulphide, l.c.l., 55 gal. drums	lb.	.05¾	Pyrophosphate, anhydrous, bags, l.c.l.	lb.	.0660
Carbon Tetrachloride, l.c.l., drums	gal.	.80	Sesquisilicate, 1-9 drums	lb.	.0430
Chromic Sulphate, scale, 100 lb. drums	lb.	.45	Stannate, drums	lb.	.365
Cobalt Sulphate, drums	lb.	.71	Sulphate, anhydrous, bbls., works	lb.	.0215
Copper, Acetate (verdigris), bbls.	lb.	.26	Sulphocyanide, drums	lb.	.55-.65
Carbonate, 52-54%, bbls.	lb.	.16½	Sulphur, Flowers, U.S.P., bbls., l.c.l. mine	lb.	.039
Cyanide, Tech., 100 lb. bbls.	lb.	.34	Tin Chloride, crystals, kgs.	lb.	.39-.39½
Sulphate, 99%, crystals, bbls., 1-5	lb.	.0535	Toluene (Toluol), 2°, ind., drums, works	gal.	.33
Cream of Tartar (potassium bitartrate), gran., kegs	lb.	.58½	Trichlorethylene, drums, l.c.l., zone 1	lb.	.08½
Crocus Martis (iron oxide) red, bbls.	lb.	.03¼	Tripoli, air floated, bgs., c.l., wks.	ton	\$26.00
Dibutyl Phthalate, drums, l.c.l.	lb.	.195-.205	Wax, Bees, white, bleached, slabs, 1-5 cases	lb.	.56
Diethylene Glycol, drums, l.c.l., works	lb.	.155	Bees, yellow, crude, Brazil, 100 lbs.	lb.	.50-.51
Dextrin, white, bags, F.O.B. Chicago	lb.	.0395	Carnauba, refined, bags	lb.	.85
Emery (Turkish)	lb.	.08	Montan, bags	lb.	.45-.46
Ethyl Acetate, 85%, l.c.l., drums, works	lb.	.09-.10	Spermaceti, blocks	lb.	.24-.25
Ethylene Glycol, l.c.l., drums, works	lb.	.15½-.18½	Whiting, precipitated, bags, l.c.l.	ton	\$18-\$25
Monoethyl ether, dms., l.c.l., wks.	lb.	.125-.155	Xylene (Xylol), ind., returnable drums, works	gal.	.32
Gold, Chloride, yellow, bottles	oz.	\$19.25	Zinc, carbonate, tech., bbls.	lb.	.20
Cyanide, potassium 41%, bottles, wks.	oz.	\$14.20-\$14.95	Cyanide, 100 lb. kegs	lb.	.33
Gum, Arabic, white, powder, bbls.	lb.	.22-.24	Chloride, tech., granular, drums, c.l., wks.	lb.	.08
			Sulphate, crystals, bbls., l.c.l.	lb.	.039

Defense Savings Pay-Roll Allotment Plan

Now company heads can help their country, their employees, and themselves

voluntary pay-roll allotment plan { helps workers provide for the future
helps build future buying power
helps defend America today

This is no charity plea. It is a sound business proposition that vitally concerns the present and future welfare of your company, your employees, and yourself.

During the post-war period of readjustment, you may be faced with the unpleasant necessity of turning employees out into a confused and cheerless world. But you, as an employer, can do something *now* to help shape the destinies of your people. Scores of business heads have adopted the Voluntary Pay-roll Allotment Plan as a simple and easy way for every worker in the land to start a systematic and continuous Defense Bond savings program.

Many benefits . . . present and future. It is more than a sensible step toward reducing the ranks of the post-war needy. It will help spread financial participation in National Defense among all of America's wage earners.

The widespread use of this plan will materially retard inflation. It will "store" part of our pyramiding national income that would otherwise be spent as fast as it's earned, increasing the demand for our diminishing supply of consumer goods.

And don't overlook the immediate benefit . . . money for defense materials, quickly, continuously, *willingly*.

Let's do it the American way! America's talent for working out emergency problems, democratically, is being tested today. As always, we will work it out, without pressure or coercion . . . in that old American way; each businessman strengthening his *own* house; not waiting for his neighbor to do it. That custom has, throughout history, enabled America to get things done *of its own free will*.

In emergencies, America doesn't do things "hit-or-miss." We would get there eventually if we just left it to everybody's whim to buy Defense Bonds when they thought of it. But we're a nation of businessmen who understand that the way to get a thing done is to *systematize* the operation. That is why so many employers are getting back of this Voluntary Savings Plan.

Like most efficient systems, it is amazingly simple. All you have to do is offer your employees the convenience of having a fixed sum allotted, from each pay envelope, to the purchase of Defense Bonds. The employer holds these funds in a separate bank account, and delivers a Bond to the employee each time his allotments accumulate to a sufficient amount.

Each employee who chooses to start this savings plan decides for himself the denomination of the Bonds to be purchased and the amount to be allotted from his wages each pay day.

How big does a company have to be? From three employees on up. Size has nothing to do with it. It works equally well in stores, schools, publishing houses, factories, or banks. This whole idea of pay-roll allotment has been evolved by businessmen in cooperation with the Treasury Department. Each organization adopts its own simple, efficient application of the idea in accordance with the needs of its own set-up.

No chore at all. The system is so simple that A. T. & T. uses exactly the same easy card system that is being used by hundreds of companies having fewer than 25 employees! It is simple enough to be handled by a check-mark on a card each pay day.

Plenty of help available. Although this is *your* plan when you put it into effect, the Treasury Department is ready and willing to give you all kinds of help. Local civilian committees in 48 States are set up to have experienced men work with you just as much as you want them to, and no more.

Truly, about all you have to do is to indicate your willingness to get your organization started. We will supply most of the necessary material, and no end of help.

The first step is to take a closer look. Sending in the coupon in no way obligates you to install the Plan. It will simply give you a chance to scrutinize the available material and see what other companies are already doing. It will bring you samples of literature explaining the benefits to employees and describing the various denominations of Defense Savings Bonds that can be purchased through the Plan.

Sending the coupon does nothing more than signify that you are anxious to do *something* to help keep your people off relief when defense production sloughs off; *something* to enable all wage earners to participate in financing Defense; *something* to provide tomorrow's buying power for your products; *something* to get money *right now* for guns and tanks and planes and ships.

France left it to "hit-or-miss" . . . and *missed*. Now is the time for you to act! Mail the coupon or write Treasury Department, Section A, 709 Twelfth St. NW., Washington, D. C.



FREE - NO OBLIGATION

Treasury Department, Section A,
709 Twelfth St. NW., Washington, D. C.

Please send me the free kit of material being used by companies that have installed the Voluntary Defense Savings Pay-Roll Allotment Plan.

Name _____

Position _____

Company _____

Address _____

Section of
METAL FINISHING

Founded January, 1903
as Metal Industry

Publication Office
116 John Street, New York

ORGANIC FINISHING

SECTION OF METAL FINISHING

JANUARY, 1942

+
CONTENTS

+
ARTICLES

Conditions During 1941 and
The Outlook for 1942 in
the Organic Finishing
Field—By G. Klinkenstein 50

Coated Abrasives—a Tool
—By E. B. Gallaher 51

Paint White for More Light
—By James A. Meacham 58

+
DEPARTMENTS

Shop Problems 61

Solvents In Industry 63

New Equipment 64

~
Picture on Cover

The photograph on the cover
is a view of one of the labor-
atories of the Forbes Varnish
Co., Cleveland, Ohio.

Finishing Materials Scarce

The outbreak of the war in the Far East placed an additional burden upon the organic finishing industry, which was already plagued by shortages of many materials, particularly those used in making synthetic enamels. Tung oil shipments to the United States from the Far East are threatened, and the production of tung oil in the United States, although greatly increased during the past several years, can only take care of a small portion of the requirements for defense. Cocoanut oil is also obtained from the Far East, particularly the Philippines, and from cocoanut oil is obtained glycerin in the process of soap-making. The already serious shortage of glycerin will be more acute, as this important commodity is used in making resins for plastics and synthetic enamels, and is also used to a great extent in explosive manufacture.

The suppliers of finishing materials have been operating for sometime on a priority basis for a large percentage of raw materials used in the manufacture of lacquers and enamels, and in some cases, the restrictions will become even more stringent. For example, toluene will be placed on an allocation basis on February 1st, and this solvent is widely used in thinners for both lacquers and enamels. Phenols and related compounds have already been placed under allocation and the available supply is not sufficient to cover all defense requirements. The same tight situation exists for metal driers.

The above situation has been mentioned to point out to our readers that the suppliers of finishing materials are beset with great difficulties in trying to supply finishing materials for both defense and non-defense. In many cases, they will recommend substitute materials which may not have the operating qualities nor the physical features of the previously supplied material, but obviously every effort should be made to use these materials. In most cases, if the substitute material is not satisfactory, there will be nothing else available. Customer good-will is appreciated and wanted by every supplier, but the primary job is the making of defense materials, and non-defense requirements can only be considered after the defense material orders have been filled.

Conditions During 1941 and the Outlook for 1942

in the Industrial Finishing Field

The industrial finishing industry, like many others, has been thrown off its normal course by the demands of defense production and the operation of priorities on raw materials. However, makers of goods without high priorities have not been prevented from obtaining finishes to meet their needs from manufacturers in position to meet rapidly changing conditions.

These changes involve both the kinds of finishes and the raw materials that are available to producers of non-essentials.

Some of the ingredients commonly used in lacquers and enamels, such as nitrocellulose, certain solvents, many types of pigments, especially whites, synthetic resins of the phenol-formaldehyde, alkyd, and urea-formaldehyde groups, and aluminum powder, can be supplied only in limited quantities, or not at all, for use by the non-essential industries.

At the same time, these industries have, in many cases, been forced to make one or more drastic changes in the composition of their products. Thus, certain manufacturers have had to switch from metal to a plastic, and then again to wood, paper mache, or other material.

Both kinds of changes create new problems for the industrial finishing industry to solve with a minimum loss of time.

The result has been the development of a series of finishes based on castor oil, soy oil, linseed oil, various organic

acids, and other substances that are not likely to be limited in supply by either our defense needs or by military operations, as is the case with tung oil and phthalic anhydride. In the hands of formulators with adequate



By G. Klinkenstein

*Vice President and Technical Director
Maas & Waldstein Company
Newark, N. J.*

skill, very satisfactory substitute finishes are thus being produced, and, in many cases, permanent additions are being made to our list of useful finishes.

Since we are planning to double our defense output in 1942 as compared

to 1941, the difficulties of manufacturers without high priorities are bound to increase, but they need have no special concern about the finishing situation, unless events take a totally unexpected turn. Solving special problems has always been the chief business of certain manufacturers of finishes, and this kind of experience is of particular value at this time.

The defense and essential industries are, of course, using finishes of all kinds in large quantities, and not much trouble has been experienced in supplying them.

At this time last year, defense work was being hampered by the fact that the government specifications for finishes were largely obsolete. This situation has been remedied. In fact, the finishing industry is now urging the government to reduce its consumption of the most modern types of finishes wherever possible, so as to permit a large amount to go to non-defense industries.

For the use of the defense industries the heaviest demand is for air-drying and baking alkyd synthetic enamels and air-drying lacquers. Wrinkle enamels are being used for special jobs, such as finishing radio cabinets, telephone panels, and small instruments.

The development of high-speed finishes and the rapid radiant heat baking process has greatly helped to speed up the production of defense products. The finishing room need never be a bottle-neck in any important industry.

Coated Abrasives — A Tool*

By E. B. GALLAHER, M.E.

General Manager, Clover Mfg. Co., Norwalk, Conn.

Introduction

COATED abrasives are abrasive materials which have been crushed and graded accurately into prescribed sizes, then applied with a suitable binder to papers and cloths for industrial purposes. The general impression, outside of those who may be using coated abrasives for production, is that coated abrasives are chiefly employed in finishing and polishing operations on both wood, metal, plastics and other products.

True, they are used very extensively for finishing these materials, but, what is not generally known, is that their more important function is the shaping or cutting to size of thousands of pieces that otherwise would have to be machined on a machine tool. In years gone by, for instance, *all* metal pieces had to be accurately machined in lathes, planers, shapers or milling machines and then they were finished and polished with abrasives.

While it is still true that such machining is necessary in most operations, yet it is also a fact that, as coated abrasives have been developed, thousands of operations that used to be done on machine tools are now being done on an abrasive belt or disc with the same degree of accuracy and at less cost.

New Techniques in Casting

This change in technique has been brought about through two major developments. Years ago, foundries could not work with anywhere near the precision that they do today. Allowances for finish in the pattern ran anywhere from $\frac{1}{4}$ " to $\frac{1}{2}$ " on medium-size pieces and even more on large pieces.

Today an allowance of $\frac{1}{16}$ " or less on small pieces is quite usual, as is $\frac{1}{8}$ " on fairly large pieces. This

means that much less metal must be removed to shape the piece to size, and this the abrasive belt or disc will do.

Another industry which did not exist a few years ago is metal die casting, where the piece is cast under pressure in a die and comes out with a high degree of accuracy, which only requires a small amount of machining to bring it to size.

Another recent development is found in the wide and ever-growing use of plastics, which are also die cast, and are employed to replace metal parts in thousands of cases.

If we had not found some better way to take advantage of these closer tolerances in castings, needless to state that all such work would have to be machined in the regular way on lathe, shaper, planer or miller.

Now, it takes a lot of time to set up work on a machine tool — more time, in many cases, than it does to do the actual machining, so it is highly desirable to eliminate the machin-

ing operation whenever possible, and do the work some other cheaper and quicker way. At the present time practically all machining of flat surfaces on die castings and on die cast plastics is being done on abrasive discs or abrasive belts.

It might be well to call attention to another problem of machining which, ordinarily, is a matter of some concern to the shop man. Where we have what might be termed a flimsy piece which has some flat surfaces on it to be machined, the danger of warping the piece during the process of machining is great. Of course, very fine cuts are taken, but even so, such pieces present a real problem for a machine tool, and the operation is slow at best. By using an abrasive belt or disc, such work is easily and quickly done with little chance of distortion.

While our foundries have learned to produce castings more accurately, and while the development of the art of die casting, and the introduction of plastics have been taking place, the art of using abrasives for the removal of metal has simultaneously taken place.

Coated Abrasive Industry Develops

Not so many years ago coated abrasives were in their infancy. The early products of this industry lacked much—they were not uniform—standards had not been developed—the art of making the grains adhere to the glue surface under extreme pressure had not been discovered—the backings of both paper and cloth were not strong enough to withstand the punishment they get when required to remove large quantities of material—the backings would stretch unreasonably when applied to a drum sander or run over fast-turning pulleys on a



E. B. Gallaher

*Presented Nov. 12, 1941 at General Motors Institute, Flint, Mich.

belt sander, etc. Well, these various problems have, over the years, been solved by the engineers and chemists of the coated abrasive industry, so that today the modern, high-grade piece of coated abrasive does stand up and do its work just the same as any other tool in the shop.

Here, then, was the answer to the problem of "machining" thousands of small and medium-sized pieces in a cheaper and quicker manner and, at the same time, maintaining the highest degree of accuracy.

During the past 15 years there has developed a complete new technique in the "machining" of small and medium-sized metal and plastic parts and the shop which has not recognized this fact is out of date. As a further proof of this trend, all one has to do is to look through the advertising pages of our technical journals and he will note the great number and variety of sanding machines which have been developed to meet almost every kind of metal working, wood working, leather working and many other operations.

New Abrasives

The great forward step in the universal use of coated abrasives came with the advent of the electric furnace abrasives—silicon carbide and aluminum oxide. It is only some thirty or forty years ago when the only shop abrasive we had was Turkish emery, a soft, dull abrasive which had very limited cutting ability. But, it served its purpose because the irons and steels of that period were soft. During this 30-year period, the development of hard steels has progressed enormously and today all shops are faced with the problem of machining and finishing steels and other metals of a hardness unknown thirty years ago. Aluminum oxide (man-made ruby) and silicon carbide (man-made diamond) are almost as hard as a diamond and the crystals are quite as sharp. So, emery has been almost completely eliminated as a cutting medium for metals and is now employed almost exclusively for polishing.

The two electric furnace abrasives are quite different in their physical properties, however. Aluminum oxide is extremely hard, but it is also tough, and the crystals are difficult to break down, even under extreme punishment—they will cut and keep on

cutting even the hardest metals until their edges wear down and become dull, like any other tool. For this reason aluminum oxide is the universal shop abrasive for all kinds of metal working, as well as for many kinds of wood working operations.

And it will be noted that these electric furnace grains do their cutting in exactly the same manner as do steel tools—the type of chip removal is the same—finer chips to be sure, but having all the characteristics of chips removed by a tool steel cutter. In other words, *an electric furnace grain is a cutting tool in every sense of the word and performs its work in just the same manner as does any other type of cutting tool.*

Silicon carbide is also extremely hard and very sharp, but instead of being tough, like aluminum oxide, the crystals are fragile and break down easily under heavy work. At first thought this would appear to be a disadvantage, but for certain classes of work it is a great advantage. As stated above, aluminum oxide crystals are tough and do not break down, but do become dull. The grains will cut for a long time; then, when they become dull, they cease to cut freely and they begin to burnish or polish just as any other tool will do. On metal work this is just what is required—the material is used for cutting down the work while it cuts freely; then, when dull, the sheet is put one side and saved for polishing work, where, after it is dipped in oil, it will produce a high luster.

Leather Cutting

On the other hand, there are certain operations where a dull crystal would ruin the work—leather cutting for instance. The principal tool in a shoe shop is silicon carbide cloth and paper which is used for cutting down and shaping the work. Here the silicon carbide crystals perform maximum work for the size of grain employed; then, as work progresses, the crystals begin to break down into finer particles. As this happens the production naturally slows down some, because the grains are now smaller, but the smaller grains are just as sharp as the larger ones were, and they cut just as clean although, being smaller, they work more slowly.

In this case, the important thing is to maintain a sharp cutting tool at all

times so as not to tear the work. Silicon carbide does just this, as it never becomes dull, but breaks down into finer particles which always retain their sharpness.

Finishing of Metals After Machining

It should also be noted that even when it is necessary to employ a machine tool to shape the work, that machine tools do not bring the work to exact dimensions, where dimensions are critical. And it then becomes necessary to further "machine" or finish the work to exact dimensions. Practically all such finishing work is done with abrasives. In fact, in most cases, it is the only way this kind of work can be done. It is not an overstatement to say that most machine shops would have to close their doors if they were cut off from their supply of abrasives. We naturally cannot cover the entire field of where abrasives are replacing other forms of machine work, but I will give a few examples:

Finishing Plywood

In the plywood industry they glue several thicknesses of wood together to form large sheets of plywood. When this sheet of plywood emerges, it is very rough and sometimes over-size in thickness by possibly $\frac{1}{2}$ inch. The practice used to be to run these sheets through a wood planer to bring the thickness to uniformity and almost to size; then it was sanded to size, and finally surface-finished with a fine abrasive.

Today, the planing operation has been eliminated entirely, and with a large 8-drum sander, the first drum using a very coarse sheet of abrasive paper, the plywood is first cut down to uniform thickness; then, as it passes through the remaining drums, it is further cut down to exact dimensions; then surface finished, so that it comes out a completely finished product—all wood removal and finishing being done with coated abrasives in one operation.

Now let me take one or two examples of machining which has been taken away from the machine tool and given over to coated abrasives.

More Metal Finishing

There is a motor used for one motorized valve which, with the control

mechanism, is enclosed in a die cast case. This case must be accurately machined on the bottom, then machined at right angles to receive an oil tight cover. This would clearly be a job for the shaper or planer, but now; the entire job is done on an abrasive disc machine with one setting of the fixture, and two perfect surfaces are obtained in much less time than it would have taken to have even *set up the job* for one surface on a machine tool.

In another case, a manufacturer of refrigerator compressors is machining both top and bottom surfaces of their cylinders and also their cylinder heads, using an abrasive belt to do the entire machining operation at one setting, with the result that they are obtaining a pressure tight joint between head and cylinder without the use of a gasket.

Another manufacturer, making a great many of the small parts for airplane engines, is doing the entire machining job on castings and forgings with abrasive belts and abrasive discs. In this case, the jobs referred to would have been done on a milling machine. These examples serve to illustrate the thousands of operations in which coated abrasives are replacing the machine tool in shaping materials to size.

I may also call attention to the fact that a part which has been machined to size on a coated abrasive belt or disc is in many cases brought to exact dimensions in the one setting, while, if the same part had been machined to *approximate* size on a machine tool, it would then have to be brought to final dimension by a second operation of sanding. Thus, in many cases one complete operation can be saved by doing the complete job on the sander.

Working free handed, it is easy to work to tolerances of 1/1000 of an inch on a precision belt machine, and by using a simple jig to hold the work, tolerances of one-half thousandth are obtained.

Cutting Speeds

One of the most important factors in the use of coated abrasives is the element of speed, and few among those who use coated abrasives realize what an all-important item this is. Speed controls the cutting efficiency of the abrasive grain, which is found to work differently at various speeds. Therefore, it is our aim to find the particu-

lar speed at which it cuts best for each kind of material on which it is employed. It has also been found that speed controls, to a great extent, the character of finish that may be expected from the various sizes of grits.

For instance, a finish obtained from a fine grit at slow surface speed can be duplicated and often improved by a much coarser grit, run at a higher speed. To illustrate: We are all familiar with the ordinary Al-Ox or Sil-Carb. grinding wheels which are run at about 3000 R.P.M. We know that such wheels will grind metals freely, and that the ground surfaces are covered with scratches and grooves, which must be finished to a smooth surface by some other means.

Well, we will take the same grain, in the same size, and we will make a thin wheel which we now run at, say, 17,000 R.P.M. Such a wheel is no longer a grinding wheel—it is a cutting-off wheel. And it will be noted that the surfaces it has left, as it passes through the metal, are as highly polished as a mirror. We see no scratches now, as we had seen when the same grit had left them on the work when run at a slower speed.

This is a grinding wheel we have been talking about, but the very same condition prevails with coated abrasives. We can obtain beautiful finishes with relatively coarse grades run at high speeds. Now, the advantage of using as coarse a grading as possible to produce our desired result must be self-evident, as the belt or disc will last longer and work quicker; therefore, we immediately have a saving in the cost in our abrasives, and we have a saving in labor, as we can produce more pieces in the same time.

Your natural inquiry would be, how can I determine the best speed for my work?—this is a fair question. I do not know what the other fellows in the industry are doing for their customers, but we, at the Clover plant, maintain a special laboratory for this very purpose. We have variable speed sanders, which produce their own graphs showing the amount of material removed for each minute of the test run. We can operate these sanders from wholly ineffective speeds to speeds so great that the belt refuses to follow the pulley and flies apart.

So, we have the full range of speeds at our disposal and can easily arrive at the correct speed for best results.

This laboratory is maintained for our customers and the work is done without cost.

When we stop to think that there are some 2000 items of coated abrasives available, and that the ordinary operator has handled possibly half a dozen kinds, you can well imagine how much information we can bring to bear on a customer's problem.

Pressure on Work

Another very important element which controls both efficiency and quality of work is the pressure which the operator applies between the belt and the work. It is safe to say that one of the greatest losses which occurs in sanding operations comes from the use of too much pressure against the abrasive belt or disc. We get much more work and a better finish by using light pressures and we avoid the possibility of burning the work or ruining the abrasive surface. We have found this question of pressure one of the hardest things to sell to the average operator, who usually figures that if he can get a certain amount of production using light pressure, he will get much more production by applying heavy pressure. This is positively not the case.

Incidentally, this human element of trying to force production through the use of too much pressure, has led to the development of automatic sanding machines, where the pressure is under positive control. Such machines invariably have a higher rate of production per belt than is obtainable by hand controlled sanding.

Many Types of Sanders

DISC SANDERS

There are several types of sanding machines, each intended for special classes of work. For instance, a disc sander consists of a round metal plate on which the abrasive paper or cloth is applied with an adhesive. Manifestly, if this disc runs true, and it is rigid in its bearings, any work which is pressed up against it will be cut down until its surface conforms to the surface of the disc, and while the coated abrasive covering may wear, it cannot lose its accuracy, which is determined by the accuracy of the metal disc.

In front of the disc, and in line with its center, there is provided a rigid,

accurately-machined table on which the work is held. This table is hinged close to the disc so that it may be moved from a horizontal position, which is at right angles to the disc, so as to produce any desired angle between table and disc. In other cases, tables are provided so that they may be moved both vertically and horizontally in order to produce compound angles. This at once gives us a most versatile machine on which many operations of shaping work can be done.

Where there are many similar pieces to be machined, it is a simple matter to make a jig, which is secured to the work table by bolts in T slots, and jigs are often made to hold the work in such a manner that several surfaces may be machined without removing the work—this assured great accuracy at a minimum cost. While most of us are familiar with small disc sanders, they are actually made in many sizes to handle a large variety of work—discs having a diameter of 48" are quite usual, and it will be seen that sizable pieces can be machined on a disc of this size.

BELT SANDERS

Belt sanders are found in many varieties. There is a type where the belt is run over an accurately machined plate, grit side up, having an accurately secured movable plate, hinged close to the belt, which can be secured at any desired angle to the belt. Belt sanders of this type are made so that the belt will run both horizontally or vertically. Some of these sanders are made adjustable, so that they may be quickly transformed for vertical or horizontal sanding, and are provided with rigid, adjustable work tables, similar to the tables employed on disc machines. A belt sander of this type is used in very much the same way as a disc sander, and the same degree of accuracy can be maintained—it is just a question of which type of machine will suit our particular operation better.

Then there is a type of belt sander which does not run the belt over a plate. This type is employed chiefly for finishing surfaces but not for accurate machining to dimension. The belt runs over pulleys which are placed either in a vertical or in a horizontal position, though the horizontal type is chiefly used. The belt runs grit side down over the work table, which may be adjusted up and down to give clear-

ance for the piece to be surfaced. The table is now adjusted so that the belt will run close to the work but does not touch it. The operator then uses a small flat piece of wood, on which the edges have been slightly rounded, with which to put pressure on the back of the running belt, in order to press it against the work which is held stationary on the work table.

This wooden pad is provided with a handle on its back which allows the operator to slide it over the belt to any point where he desires to press the belt against the work; thus he has complete control as to where he wishes to sand and the amount he wishes to remove. The contact surface of this wood pad is usually treated with wax or covered with graphite to reduce friction between it and the back of the belt. By using the rounded corner edge of his pad and drawing it rapidly over the entire length of the work, he can obtain a highly uniform surface. Such machines are employed for finishing all kinds of surfaces—metal, wood, etc.

Often it is necessary to machine inside surfaces, such, for instance, as the finger openings in scissors, surgical instruments, etc. We have all noticed how beautifully finished are the irregular surfaces of scissors, especially the interior surfaces of the finger openings, and some may have wondered how this work is done.

Surgical instruments and scissors are drop forgings made of very hard steel. In the rough, the surface is anything but smooth, and there are sharp, hard fins of metal sticking out which are left by the forging dies. To dress these forgings down by hand would make the cost prohibitive, but to machine them on a coated abrasive belt not alone assures their accuracy, but gives a perfect finish at very low cost.

There is a type of belt sander which is employed for sanding the inside of these finger holes and for similar operations which is most interesting. Long, narrow belts are used, which are run over two flanged pulleys. One of these pulleys is the drive pulley—at the other end is a loose pulley, mounted on a swinging arm, which arm is held by a spring, so that when a belt is placed over the two pulleys it is kept in tension by the spring, a foot pedal is provided which works against the spring and allows the operator to bring the swinging arm forward and

thus remove all tension on the belt.

The belt being in operation, the operator presses down on the foot pedal, removes the belt from the loose pulley, allowing it to hang slack on the flanged driving pulley; then he passes the entire belt through the finger hole of the scissors forging, replaces the belt on the loose pulley and removes his foot from the pedal. The spring takes up the belt slack and the belt begins to operate at high speed. By twisting and turning the work on the belt, it is cut down to size rapidly, and a smooth, perfect surface is obtained. To remove the work, the operation is reversed.

I have seen surgical scissors finger openings machined in this manner at the rate of one hole a minute—the same work done by hand would take at least one-half hour, and then not be as well done.

DRUM SANDERS

The drum sander is another type of sanding machine which is made in several forms for different classes of work. Some drum sanders have a top and bottom sanding roll, between which the work passes to be sanded on both sides at once, while other types employ only a top roll, the work being carried on a conveyor belt to sand one side only. This conveyor belt passes over a supporting plate, which insures an accurate cut over the entire surface of the work.

SPINDLE SANDERS

Another form of sander is called a "spindle sander" which consists of a fast turning shaft with a spindle on one or both ends, to which is attached an abrasive "sleeve." These sleeves are made in many diameters and lengths, and are used to sand irregular surfaces, such as gun stocks, and many metal, plastic and die-cast parts. Sanding spindles are sometimes solid "shaped" pieces over which the sanding sleeve is slipped, with the purpose of making the work conform to the shape of the spindle. In other cases, where the work has already been rough shaped, such as a gun stock, pneumatic spindles are used. In this case, the abrasive sleeve is placed over the pneumatic spindle, which is then inflated. This presents a flexible contact to the work and the sanding conforms to the shape of the piece.

Then there are the many forms of sleeves, cones and discs which are



Durability . . .

Silence is not *always* golden. Lasting quality . . . the ability to withstand wear . . . is admirable. But consider the Sphinx. No one remembers the name of the builder.

Remember this fact when you select a finish for your product.

Creating the *right* finish requires the same inventive ability, the same engineering skill and the same productive capacity as the product itself. Durability is no longer enough. Problems of application, cost, appearance, specific characteristics to meet specific requirements, may be equally important.

We can help you create a finish to fit your product **EXACTLY** . . . a finish engineered to your **SPECIFIC** needs. Finish should be your best salesman. Don't use one that's *dumb*!

Your inquiry incurs no obligation. Address Department "A"



THE STANLEY CHEMICAL CO.

EAST BERLIN CONNECTICUT

Lacquers · Enamels · Synthetics · Japans

A SUBSIDIARY OF THE STANLEY WORKS, NEW BRITAIN, CONN
ORGANIC FINISHING SECTION

especially made for use with flexible shaft machines for getting into corners, angles, etc.

OTHER SANDERS

Another complete line of sanding machines are available for inside surfaces of both metal and wood—toilet seats are a fair example of an inside sanding job. These inside surface sanders usually consist of a large driving pulley at one end of the belt, which is then carried over a small pulley at the other end, or over a straight

edge which is mounted on an extension bracket, so that the work may be slipped over it.

Then there are moulding sanders, where the belt is "shreaded" or cut into narrow strips to allow it to conform to the irregular surfaces of the moulding. While I have mentioned a few of the important types of sanding machines, there are many others which, for the work they are intended, are just as important.

Generally speaking, the thought behind this article is that machine tools

represent large investments, and, therefore, should not be required to do any work which can be done with the same degree of accuracy, by some other, less costly means. This argument, it seems to the writer, would be valid even in normal times when our machine tools are engaged in work for a peace economy. Now, however, when every machine tool is sorely needed on defense production, it would seem all the more important to relieve them of all possible work, and the coated abrasive belt and disc is apparently the answer for thousands of small and medium size jobs.

Spangle Shows Thru One-Coat Enamel

Question. A short time ago we began finishing galvanized iron in a high gloss black baking enamel. The enamel we are using is most satisfactory except that occasionally the spangled pattern of the galvanizing shows through the finish. When this occurs it becomes necessary to apply a second coat and at times a third coat. The difficulty is that each piece must be subjected to a one hundred per cent inspection and rerouting the defective parts through the spray room and baking oven is most troublesome.

Can you make any suggestion as to how we may eliminate this?

Answer. The most obvious and perhaps the best means of eliminating the show-through of the pattern of galvanized iron is to use a primer designed for the purpose. Since your final coat is black and you are not limited to using a light colored primer of low hiding power, securing one which would mask the spangle should not be difficult.

It is understood that you do not want to increase the number of your finishing operations any more than is necessary. Therefore, we suggest that you investigate the modern flash primers. These primers, used under baking materials, do not require an individual bake. After being applied, they are allowed to stand for a few minutes. The baking material is then applied and the two coats baked together.

This system, properly handled, should eliminate your difficulty and give an excellently smooth finish.



SKILSAW DISC SANDERS
ARE WAY AHEAD AT THE FINISH!

SKILSAW DISC SANDERS do all finishing jobs faster, better and at lower costs... because they are more powerful, more rugged, more dependable. In every industry they are preferred for surfacing work in production, repairs and general maintenance. They file, grind, buff, sand and polish on flat or curved surfaces of wood, metal, stone, tile and compositions... with grinding wheels, wire brushes, polishing bonnets, rubbing pads and sanding discs. Everywhere... in every way... SKILSAW DISC SANDERS ARE way ahead on every finishing job. Ask your distributor to demonstrate them for you. 5 powerful models to choose from.

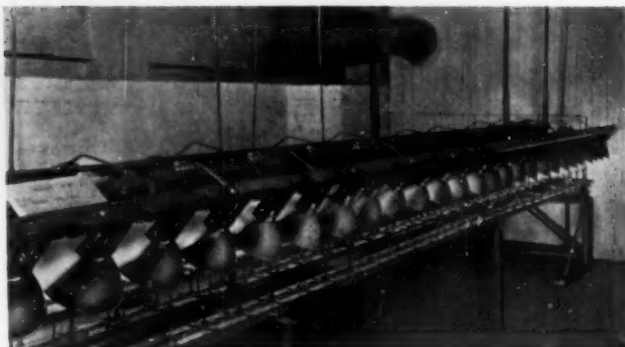
SKILSAW, INC., 4765 Winnemac Avenue, Chicago, Ill.
New York • Boston • Buffalo • Philadelphia • Cleveland • Kansas City • Atlanta
New Orleans • Dallas • Los Angeles • Oakland • Seattle • Toronto, Canada

SKILSAW **PORTABLE ELECTRIC** **TOOLS**
★ **FOR THE DEFENSE OF AMERICA** ★

WHAT AND HOW MUCH INFRA-RED CAN DO FOR YOU

Infra-Red Baking and Drying systems designed and installed by Gifford-Wood are saving time, money and space to an almost incredible extent. Four-hour drying jobs have been cut to four minutes. Power costs have been reduced 75%. Drying space has been cut in half. Tough and costly baking operations have been made relatively simple and inexpensive.

Gifford-Wood designs and installs complete drying and baking systems, with unique NI-R type conveyors that contribute mightily to success. This Company was one of the first to see the industrial possibilities of Infra-Red drying and baking, and to develop for this work special conveyors to do what no stock conveyors could accomplish.



Write for new Gifford-Wood bulletin No. 150 describing and illustrating various operations and installations. Let Gifford-Wood engineers study your problem—then tell you exactly what you could expect from an Infra-Red installation, *what savings will be yours, and how much it will cost.*

GIFFORD-WOOD CO.

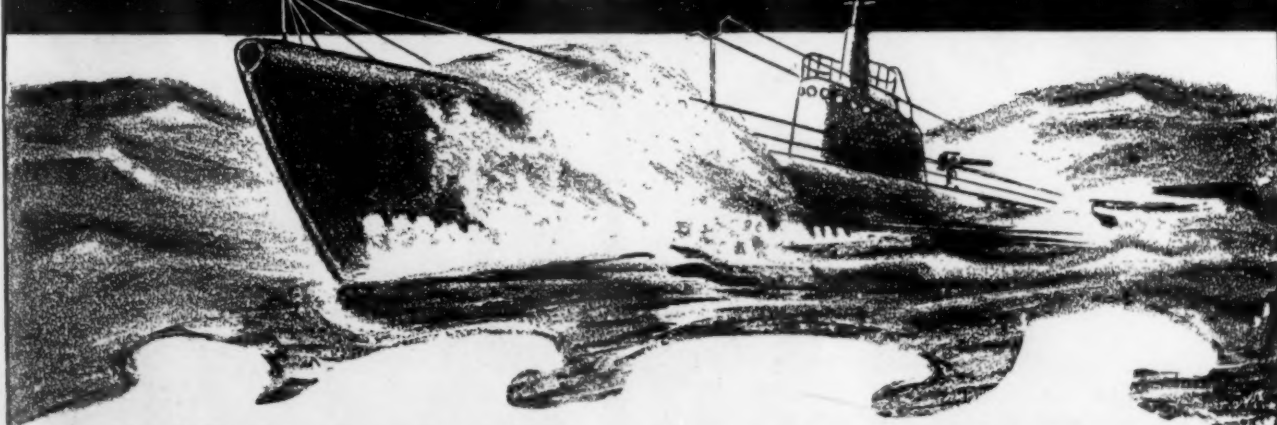
HUDSON, N. Y.

New York
420 Lexington Ave.

Chicago
565 W. Washington St.

2926

PROTECTIVE FINISHES FOR DEFENSE!



We look forward, now, as earnestly as ever, to serving you and serving our nation. We are deeply appreciative of your past patronage and your friendship during the present national emergency. Please call on us for any counsel or help, without any obligation on your part.

Always At Your Service **The CLINTON Co.** 1210 Elston Ave., Chicago
Manufacturers of CLINCO Quality Industrial Finishes

PAINT WHITE FOR MORE LIGHT*

By James A. Meacham

*Director, Maintenance Division,
Sherwin-Williams Company*

FOR some time now increasing stress has been placed on the value of painting plants to achieve greater visibility. Most cooking and heating appliance manufacturers have always known the value of paint, but few have realized fully what an enormous difference scientific painting means in terms of illumination, cleanliness, brighter surroundings, safety and better working conditions.

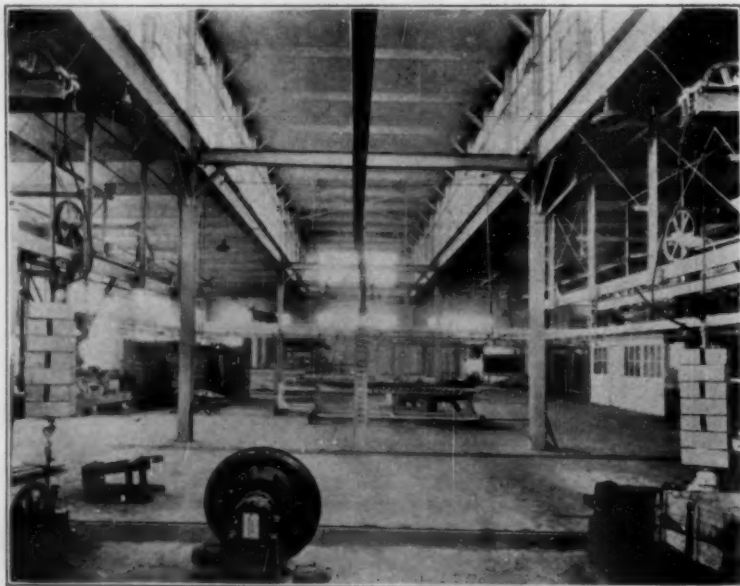
That situation is changing rapidly. The up-to-date appliance plant executive now knows that paint properly selected can and does make for greater plant efficiency, and as a result, factories of the industry are emerging from their veritable "dark age" into a lighter and brighter day, all through the medium of paint.

White paint is the No. 1 aid to workers handicapped by poor lighting. White paint on walls and ceilings not only affords the desirable clean appearance, but also gives the maximum amount of light reflection and a more even distribution of light over the entire floor area, especially noticeable in areas away from windows. Less artificial light is required to give more abundant illumination, with a resultant saving in lighting costs.

Where light is improperly distributed, deep shadows contrast strongly with bright areas. Each time the workers look up from a brightly lighted area into dark surroundings, their eyes must adjust themselves to the difference in lighting intensity. This constant adjustment causes eye strain and fatigue. The use of white paint, eliminating darker areas and improving the uniformity of general illumination, overcomes this common cause of eye strain. The reason is that the eye is not conscious of glare when light is reflected equally in all directions from a point having good diffusing properties. The brightness of such a surface appears equal from any angle. The shadows are luminous and soft.



View of enameling building of American Stove Company, Lorain, Ohio, before and after first application of one-coat Save-Lite Flat.



*Reprinted from "The Stove Builder."

Interestingly enough, a diffusely reflecting flat or eggshell paint reflects as much or more light than a gloss paint. For painting plant walls and ceilings, therefore, the selection of gloss involves a compromise between maximum reflection and freedom from glare on the one hand and the greater durability and ease of cleaning of the higher gloss finishes on the other.

In light-reflecting value and ability to diffuse light, a flat white newly applied is considered superior. An egg-shell white finish approaches very closely the reflecting and diffusing power of flat, with the advantage of easier cleaning and greater durability. Gloss and semi-gloss finishes are the most durable of all and the most highly resistant to moisture, and are most easily cleaned. Walls painted with gloss white give an effect of gleaming beauty and spotless sanitation. But with higher lighting standards, the better light-reflecting and diffusing properties of eggshell and flat finishes have made them the most popular types where moisture conditions and other hazards are not a factor.

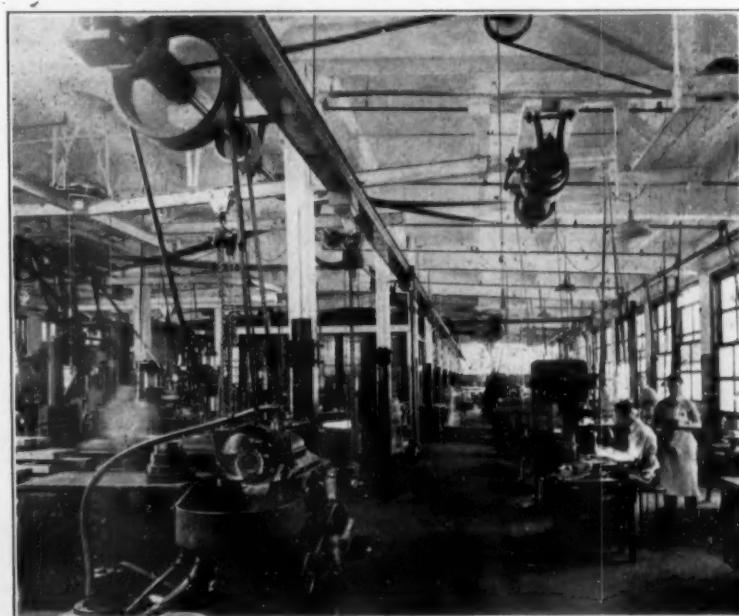
Minimum Foot Candles Recommended

Varying operations in cooking and heating appliance manufacturing plants demand varying amounts of light. The following table gives the lighting standards recommended by the Illuminating Engineering Society for different types of work:

Operation	Foot-Candles Recommended
Machine Shops:	
Rough bench and machine work	10
Medium bench work, rough grinding, etc.	20
Fine bench and machine work	50-100
Extra fine work	100
Sheet Metal Work:	
Ordinary bench work	15
Punches, presses, shears	20
Medium bench work	20
Tin plate inspection	50-100
Assembling:	
Rough	10
Medium	20
Fine	50-100
Extra fine	100
Paint Shops:	
Dipping, spraying, firing	10
Ordinary hand painting	20
Fine hand painting	50-100
Extra fine painting, finishing	100
Inspection:	
Rough	10
Medium	20
Fine	50-100
Extra fine	100



Before: Increased light at working levels is achieved in the shop of a midwest metal-working plant by a one-coat spray job on walls and ceilings, with a high-light-reflecting white paint which reflects nearly 90 per cent of all natural or artificial light entering the plant. Ceiling and wall surfaces were badly soiled and as the photograph shows, were nearly black. Light entering the windows was absorbed with the result that shadows and glare were inevitable.



After: One coat of the new light-reflecting white paint, which was developed by the Sherwin-Williams Company chemists and which is known as Spraying Eg-Shel Save-Lite, made the change shown above. Light entering the windows is now reflected toward working levels by the white ceilings and girders, with the result that shadows are practically eliminated and available light is greatly increased for precision work. The paint rejuvenation also contributes to better housekeeping and improved morale, the plant officials state.

Varying conditions demand varying amounts of light, and the selection of white paint or use of other colors depends upon conditions. Much has been learned about the use of colors for industrial purposes. For example, it has been found that various tints applied to dados, machines and other equipment not only increase the opportunity for creating an attractive appearance, but also, if chosen with respect to psychological values, they will improve employee spirit and efficiency.

Contrasting colors applied to operating levers make faster handling and greater safety possible. Red applied to danger zones improves safety. Cool colors, such as blue or green on lower portions or trim of excessively warm rooms; or warm colors, such as red, orange or buff, on refrigerator dados or for cool rooms will promote a feeling of comfort where employees are obliged to work under these extremes. Pipe line enamel colors used as markings on white or light-tinted pipe lines will facilitate identification without detracting from the white appearance sought in the plant.

It is important to remember, for purposes of general illumination, that the proportion of light reflected, the light most useful in seeing, varies greatly with different colors and different shades of the same color. The lighter the color and the lighter its shade, the more light is reflected. The accompanying table specifies the light reflection values of several colors, white heading the list by a considerable margin:

Reflection Values of Paint Colors

Color	Per cent
White	89
Ivory	82
Canary Yellow	77
Cream	77
Caen Stone	76
Orchid	67
Cream Gray	66
Ivory Tan	66
Sky Blue	65
Buff	63
Pale Green	59
Shell Pink	55
Bright Sage	52
Silver Gray	46
Olive Tan	43
Forest Green	22
Cocanut Brown	16
Black	2

Special Paints Available

The exact paint to be applied should be governed by existing conditions. The presence of fumes or gas, if strong, will require paints specified as fume-resistant. Conditions of excessive heat or temperature extremes require paints employing vehicles and pigments that do not break down and discolor when exposed to heat, and vehicles that possess unusual flexibility. The formulation of these paints varies with different manufacturers, but important to executives and maintenance men is the knowledge that special paints exist that are designed to give lasting service at a substantial saving.

Concrete paints for interior or exterior use are oil-type paints differing from standard outside paint in that they are given a vehicle which prevents overabsorption by porous concrete, and cover evenly on the rough texture. New concrete surfaces are best treated by washing down with a solution of 1½ to 2 lb. of zinc sulphate crystals to a gallon of water. This will minimize the dangers from free alkali. If the concrete is rough or porous it will be advantageous to apply a coat of primer and sealer about 48 hours after the wash down under normal drying conditions.

Paint should never be applied over loose paint, or on greasy or damp walls. Cracks and crevices should be filled with a special paint filler. Regular and fume-resisting paints are obtainable in gloss, semi-gloss and flat, as are the standard paints, and may be applied by brush or spray gun.

Concrete floors require the application of floor enamels which have excellent sealing and wearing qualities. Unpainted concrete floors absorb considerable moisture, take up odors, hold dust, form breeding places for germs and insects, and are difficult to wash thoroughly clean. Neglect of concrete floors also results in their gradual deterioration and disintegration due to moisture conditions, the presence of various oils and chemicals. Good grade floor enamels have a high gloss and possess remarkable wearing qualities. If lighter colors are used there will also be less absorption of light by floor areas, and the general appearance of the plant will be distinctly enhanced.

Where color is of no concern in a concrete coating, as in storage rooms

or other isolated areas, finishes known as concrete hardeners are generally satisfactory. These hardeners are usually colorless and possess a high gloss like that of clear varnish. They are a water solution of rock-forming substances which remain dissolved in water until they come in contact with the alkaline substances in concrete. The resulting chemical reaction forms an insoluble rock substance that is exceedingly hard and resistant to moisture.

Painting Steel and Iron Surfaces

Structural steel and iron surfaces, interior as well as exterior, are best treated by the application of a lead chromate base paint after removing all rust, scale, grease and moisture from the surfaces. The lead chromate type metal primer, given a vehicle of a fine balance of refined linseed oil resins and tung oil, will inhibit corrosion and stand months of abuse and wear, even though the application of a suitable final coating may be delayed. Final coatings of metallic, graphite-carbon paint, or prepared building paint (for special colors or white) will be found very satisfactory. Where heat is extreme, heat and fume-resisting metallic paints are to be preferred.

Enamels known as engine enamels will withstand appreciable amounts of heat and combine a choice of colors with a smooth lustral finish. Metallic paints applied to radiators result in a loss of heat radiation amounting to nearly 17 per cent. White and light tints show practically no loss. This is an important consideration in painting pumps, air compressors and other units as well as radiators, where it is desirable to dissipate heat as rapidly as possible.

Where it is desirable to paint galvanized metal surfaces such as exhaust ducts, bins, roofs or siding of buildings, it is important that the surface should be permitted to become etched through weathering for at least six months or else be treated to avoid wholesale peeling of the paint applied. New metal or galvanized metal in interiors that are to be painted should be washed down with a solution of 8 oz. of copper sulphate to the gallon of water, and preferably given a priming coat, with a special zinc pigment primer. Another method is to wash the

metal down with a solution consisting of 1 gallon of 56 per cent commercial acetic acid to 2 gallons of water. After the surface has dried it may be coated with a suitable primer. Final coats of a white or light-tinted paint will aid in keeping interiors of galvanized metal buildings cooler in hot weather. Composition wood or paper roofs are best preserved and waterproofed by the use of good grade coal-tar roof paints and cements. Such coatings withstand the heat of the sun without drying out, and are resistant to fumes and other adverse conditions. Liquid roof cements combining pitches, oil and long asbestos fibers will be found particularly satisfactory for badly worn roofs.

The selection of the right type of finish of a good grade is fundamental to achieving the desirable attractive appearance, lasting serviceability and reduced operating and maintenance costs. It is a means of cutting lighting costs, reducing accidents, increasing operating efficiency, improving employee morale, enhancing the appearance of the building, and most important of all, proper painting procedures afford better control of production and final quality. Leading paint manufacturers have established a free service in preparing painting standard and procedure charts for firms desiring to put painting on a scientific production and cost basis and in the last analysis they are the simplest and best answer to effective painting.

Shop Problem

Substitute Thinners

Question. We have recently been experimenting to find thinners for our enamels other than the ones offered by our paint suppliers. Our object, of course, is to find more than one thinner for each enamel so that if one becomes unavailable we will have another with which to replace it. Thus far, we must admit, we have had more difficulty than success. While some of the thinners we have tried seem to accomplish thinning satisfactorily,

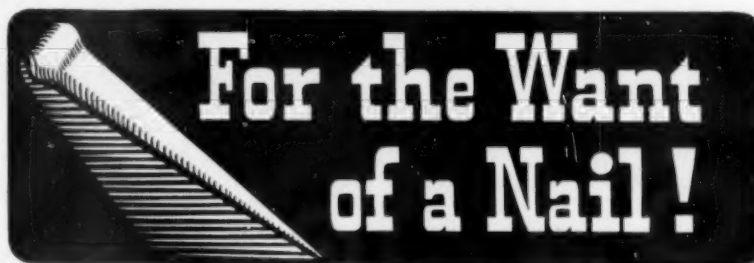
batches of enamels containing these thinners remain quite tacky and in the case of a white enamel show considerable yellowing after baking.

We will be greatly indebted to you if you will advise us as to where we might obtain directions for testing thinners so that we will not have to proceed with our experiments on a trial and error basis.

Answer. While numerous tests have been developed for determining the properties and characteristics of solvents, it is not believed that such tests are the answer to your problem. We gather from your letter that you are not familiar with the formulation of

your various finishing materials and without this information the results of solvent tests are almost worthless. Even assuming that you did know the composition of your finishing materials, considerable time, equipment, and experience would be necessary to determine what thinners would suit your needs, particularly if your finishing materials require thinners which are combination of two or more solvents.

It is suggested that you present your problem to your finishing material suppliers. Undoubtedly they can and will recommend substitute thinners if for any reason they believe that they will not be able to supply all of your requirements from their supplies.



*For want of a Nail
A shoe was lost
For want of a Shoe
The horse was lost
For want of a Horse
The rider was lost
For want of a Rider
The battle was lost
For want of a Battle
The Kingdom was lost
All for the want
Of a Horseshoe Nail*

— B. FRANKLIN

*F*or the want of a proper finish a product, too, can be lost.

This is especially true of defense items which must be produced on a rigid schedule and with which no manufacturer can afford to experiment at this time.

Egyptian Finishes, known to and used by industry for a half century, are becoming increasingly important in the finishing of hundreds of defense products.

We will welcome an opportunity to discuss your requirements with you, and we cordially invite your inquiry.

THE EGYPTIAN LACQUER MANUFACTURING CO.
ROCKEFELLER CENTER NEW YORK



**"Ordinary Type Dust Collectors
Must Not Be Used
for Removing Magnesium Dust"**

**...SO SAY
LEADING CHEMICAL ENGINEERS**

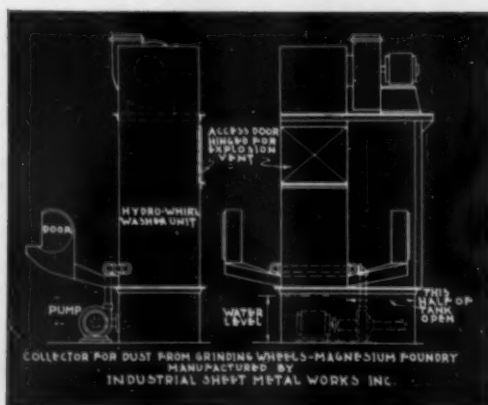
The Hydro-Whirl meets all requirements for magnesium dust control.

Its high efficiency is attributed to the effective manner in which all the dust is trapped in the water. This new principle of dust control introduces the vital factor of safety which results in reduced explosion and fire hazards.

This collector is recommended by one of the largest Fire Insurance companies in the country.

If you process magnesium—grind, buff, or polish—you need the most efficient way of arresting the dangerous action of the dust. The Hydro-Whirl has it.

Send for the new folder.



Industrial Sheet Metal Works
Manufacturers of Hydro-Whirl Dust Collectors and Spray Booths, Grease and Parts Washers.
Completely Engineered and Installed

617 E. Forest Ave.

Detroit, Mich.

**Boost Speed and Quality of Drying
... Reduce Drying Costs with a**

KREIDER Centrifugal Dryer



Centrifugal Drying gives your plating room fast, easily controlled drying that speeds and improves your production—reduces your costs.

The new Kreider Centrifugal Dryer assures modern high-speed drying at its best. This Kreider Dryer is simple in design, easily operated by one semi-skilled worker.

All steel, electric welded construction.
• V-belt driven.
Built-in belt tightener.
• Anti-friction bearings, alemite grease fittings.

AUXILIARY HEATING UNIT—Scientifically designed steam unit heater with electric blower available to use in drying small parts or where a cold water rinse is used.

Send for
Bulletin and Prices

DELLINGER MANUFACTURING CO.
727 North Prince St., Lancaster, Penna.

SHORTAGES??

For OLD and NEW PRODUCTS

USE

FLOCK

For

Velvet effects
Suede effects
Novel effects

From

Rayon — Cotton

★ **USE THE STAR FINISH** ★

Write

RAYON PROCESSING CO. 80 Tremont St.
Central Falls, R. I.

Solvents In Industry

The Amyl Alcohols

There are eight amyl alcohols. Although all of the eight have the same empirical chemical formula ($C_5H_{11}OH$) and have the identical molecular weight (88.09), they differ from each other in their chemical structure. In other words, while each amyl alcohol has the same number of carbon, hydrogen and oxygen atoms, the manner in which these atoms are linked together is entirely different in each one. Because the isomers of amyl alcohol differ structurally, they possess different chemical and physical properties and characteristics. This phenomenon is referred to as isomerism and the variations are known as isomers.

Table 1, gives the names, formulae, boiling points and specific gravities of the eight amyl alcohols.

With the exception of neopentyl alcohol (also called simply primary amyl alcohol) which is listed as being crystalline under ordinary conditions, the amyl alcohols are all colorless, water-white liquids. They vary in specific gravity from 0.809 (approximately 6.74 pounds per gallon) in the case of tertiary amyl alcohol to 0.819 (approximately 6.82 pounds per gallon) in the case of secondary isoamyl alcohol.

Like most alcohols, the amyl alcohols are miscible with most of the common organic solvents including esters, ketones, ethers, other alcohols, various hydrocarbons, etc. They are good solvents for many but not all waxes, fats, gums, oils, resins, etc. and in some instances for inorganic compounds, notably sulphur, phosphorous and iodine. Inasmuch as their boiling points lie between the limits of 100° and 150° Centigrade, they are classed as medium boiling solvents, evaporating more rapidly than benzyl alcohol but more slowly than acetone.

The amyl alcohols are somewhat less soluble in water than the propyl alcohols and considerably less soluble than the butyl alcohols. Recorded data show that the average solubility in water is of the order of five per cent although in one case, that of secondary active amyl alcohol, the solubility is as high as 16.7 per cent.

Manufacture

The first commercial source of amyl alcohols, and one which still accounts for an appreciable portion of these materials, was fusel oil, also known as grain oil and potato oil. This liquid, more or less colorless and of a somewhat disagreeable odor, is the by-product of the preparation of ethyl alcohol by fermentation and contains among other things a mixture of some of the isomers of amyl alcohol. By careful processing of fusel oil it is possible to obtain what is referred to as refined amyl alcohol, predominantly a mixture of primary isoamyl and active amyl alcohols.

Another source of amyl alcohols is the pentanes found in natural gas and gasoline.

Table 1. The Amyl Alcohols

Name	Formula	Boiling Point	Specific Gravity
Primary Normal Amyl Alcohol (butyl carbinol) (1-pentanol)	$CH_3(CH_2)_3CH_2OH$	137.9	0.817
Primary Isoamyl Alcohol (isobutyl carbinol) (3-methyl-1-butanol)	$(CH_3)_2CHCH_2CH_2OH$	130.5	0.812
Primary Active Amyl Alcohol (secondary butyl carbinol) (2-methyl-1-butanol)	$CH_3CH_2CH(CH_3)CH_2OH$	128	0.816
Neopentyl Alcohol (tertiary butyl carbinol) (2,2-dimethyl-1-propanol)	$(CH_3)_3CCH_2OH$	114	0.812
Secondary Active Amyl Alcohol (methyl propyl carbinol) (2-pentanol)	$CH_3CH_2CH_2CHOHCH_3$	119.28	0.809
Secondary Isoamyl Alcohol (methyl isopropyl carbinol) (3-methyl-2-butanol)	$(CH_3)_2CHCHOHCH_3$	114	0.819
Secondary Amyl Alcohol (diethyl carbinol) (3-pentanol)	$CH_3CH_2CHOHCH_2CH_3$	115.6	0.815
Tertiary Amyl Alcohol (dimethyl ethyl carbinol) (2-methyl-2-butanol)	$CH_3CH_2C(CH_3)OHCH_3$	101.8	0.809

Normal pentane [$CH_3(CH_2)_3CH_3$] and isopentane [$(CH_3)_2CHCH_2CH_3$] are separated from the gas or gasoline and treated with chlorine gas to produce amyl chlorides. These compounds are then hydrolyzed with sodium hydroxide to produce various amyl alcohols including the primary normal, primary iso, primary active, secondary active and secondary isomers.

The chemical reactions of this process may be stated as follows:



Other methods for synthetically producing

amyl alcohols have been developed. For example, secondary amyl alcohol may be made by a process similar to that above except that amylene, an unsaturated hydrocarbon obtained from the cracking of gasoline, is used as the starting material. The amylene is treated with sulphuric acid to produce amyl hydrogen sulphate. This compound is then hydrolyzed to form the alcohol.

Still another process, by which primary normal amyl alcohol has been made involves the decomposition of castor oil to form valeric acid. This valeric acid is then reduced to primary normal amyl alcohol.

	Tertiary Amyl Alcohol	Fusel Oil
Color	water-white	water-white
Specific Gravity	0.81 at 20°C.	0.811-0.815 at 20°/20°C.
Acidity	not over 0.15 mg. KOH per gm.	free acid as acetic acid not more than 0.02%
Non-volatile Matter	max. 0.006 gm. per 100 cc. at 100°C.	not more than 0.005 gm. per 100 cc.
Flash Point	75°F. (open cup)	approx. 108°F. (closed cup)
Water Content	none	miscible without turbidity with 20 vols. 60° Be. gasoline at 20°C.
Distillation Range	below 98.0°C. . . . none below 99.5°C. not more than 5% below 107.0°C. not less than 95% above 110.0°C. . . . none	below 110°C. . . . none below 120°C. not more than 15% below 130°C. not less than 60% above 135°C. none
Weight per Gallon	approx. 6.75 lbs.	approx. 6.76 lbs.
Water Solubility		100 cc. dissolves 9.9 cc. of water at 25°C.

Specifications

Given above are specifications for one grade of tertiary amyl alcohol and one grade of fusel oil. The former is made synthetically from pentane, while the latter is obtained from the fermentation of molasses. Both are commercial products used as solvents in the finishing industry. The tertiary amyl alcohol contains small amounts of other amyl alcohol isomers. The fusel oil is predominantly primary isoamyl alcohol with primary active amyl alcohol and small amounts of lower boiling isomers.

Uses

The amyl alcohols find many and diversified applications in industry, medicine and science. In the field of organic finishing the amyl alcohols are important solvents. Tertiary amyl alcohol and refined fusel oil are especially useful. Good resin solvents, they possess good blending properties, promote good flow and impart gloss. While not solvents for nitrocellulose, they are latent solvents. The acetic acid esters of these materials are excellent solvents.

Other applications of the amyl alcohols are: primary amyl alcohol as a photographic chemical; tertiary amyl alcohol as a constituent of dry cleaning fluids; in dyeing textiles; in the vulcanization of rubber; as constituents of fruit essences and perfume preparations; in the separation of mineral ore from gangue; in the synthesis of organic chemicals and pharmaceutical compounds such as methyl propyl ketone, an ethyl alcohol denaturant; amyl nitrite, used for the relief of angina pectoris; and amyl barbitol, an important sedative.

Paint

U. S. Pat. 2,262,174 G. Flanagan, Jr., assignor of one-third to E. L. Gruber, Nov. 11, 1941. A paint composition comprising 53% volatile matter consisting of 55 parts water and 45 parts alcohol, and 47% non-volatile matter consisting of 35 parts shellac resin, 8 parts casein, 12 parts zinc sulfide, 5 parts calcium carbonate and 40 parts siliceous extender.

New Equipment

Drum and Barrel Carrier

Ernst Magic Carrier Sales Co., 1456 Jefferson Ave., Buffalo, N. Y., have added to their line a new model drum and barrel carrier. This model was designed and constructed for handling litherage drums, which are principally used as containers of heavy materials.



Drum and barrel carrier

It is stated that one man using only one hand can handle the drum where several men were formerly employed, and in addition accidents common to handling loaded containers are prevented by the simple lifting device and self-balancing design.

The small sized model has a capacity up to 600 lb. and other carriers are available with capacities up to 1500 lb.

Life Test on Spray Nozzle

"How long will a Milburn needle and nozzle remain in operating condition?"

This question has been asked by dozens of prospective spray gun customers, and in order to establish a satisfactory reply, the Engineering Department of the Alexander Milburn Company, Baltimore, conducted a test.

A Type OM Gun was equipped with a #53 stainless steel nozzle and needle, and then attached to an air motor. A counter was applied, and over a period of 32 days, the gun was operated 817,081 times. At the conclusion of the run, the needle and nozzle were found to be in perfect condition.

This company offers a chart showing the various head and nozzle assemblies for all types of materials sprayed by Milburn siphon and pressure-feed guns. For a copy of this chart, write the Alexander Milburn Co., 1493 W. Baltimore St., Baltimore, Maryland.

U. S. Government Finishes

Roxalin Flexible Lacquer Co., Elizabeth, N. J., have recently issued bulletins describing four products to meet Government Specifications. These materials are: "Quick Drying Metal Primer" (lacquer type) to meet U. S. Army Specification 3-165-A, "Quick Drying Pyroxylin Surfacers" to meet U. S. Quartermaster Corps Tentative Specification ES-347, "Lustreless Coronado Tan Synthetic Enamel" to meet U.S.Q.M.C. Tentative Spec. E.S. 680, and "Olive Drab Lacquer" to meet U. S. Quartermaster Corps Specification ES-349. Important information on these products is given, such as uses, extent of thinning, application of the material, film thickness and drying properties.

WALKER'S

Finishes to Fit the Product

Zinc Chromate Production Primers, Fillers, Surfacers & Undercoats, Short High Bake Enamels, Chlorinated Rubber Enamels, Rapid Drying Synthetic Enamels, Lacquers and Enamels for all Surfaces, Wrinkle Enamels and Novelty Finishes.

H.V. WALKER CO.
MAKERS OF FINE FINISHES
ELIZABETH, N.J.

100% Availability
Industrial Lacquers and Enamels
For Fine Finishes
SEE KIRKER

Kirker Chemical Corporation
PATERSON NEW JERSEY

Founded as METAL INDUSTRY,
January, 1903 by
PALMER H. LANGDON
1868-1935

METAL FINISHING

VOLUME 40

FEBRUARY 1942

NUMBER 2

Publication Office:
116 John Street, New York



L. H. LANGDON
Publisher

THOMAS A. TRUMBOUR
Business Manager

DR. WALTER R. MEYER
Editor

PALMER H. LANGDON
Assistant Editor

JOAN TRUMBOUR
Advertising Manager



PUBLISHED MONTHLY—Copyright 1942
by The Metal Industry Publishing Company,
Incorporated, 116 John St., New York,
N. Y. Entered February 23, 1903, at New
York, N. Y., as second class matter under
Act of Congress, March 3, 1879. Re-
entered as second class matter June 13,
1940, at the post office at New York,
N. Y., under the Act of March 3, 1879.

SUBSCRIPTION PRICES: United States,
\$2.00 per year; Canada, \$2.50 per year
(includes 50c exchange and tax). Foreign
\$5.00. Single copies 25c. Please remit by
check or money order; cash should be
registered.

ADVERTISING RATES on application.
Forms close the first of the month. Adver-
tising copy should be mailed in time to
reach us on or before the 20th of the pre-
ceding month.

METAL FINISHING reserves the right to
investigate all products offered for adver-
tisement, to refuse advertising considered
unsuitable and to edit advertising copy when
necessary.

CONTENTS

Editorial	67
Defense Highlights	68
The Chrome-Hardening of Cylinder Bores—By H. Van der Horst	69
The Electrodeposition of Silver from Thiosulphate Solutions—By Robert Weiner	74
Electrolytic Zinc Coated Wire—By L. H. Winkler	76
Magnesium Alloy Processing—By James P. ApRoberts	84
Organic Finishing Section	
Anodic Treatment of Aluminum in the Chromic Acid Bath—By O. F. Tarr, Marc Darrin and L. G. Tubbs	106
Finishing of Washing Machines—By Carleton Cleveland	112

DEPARTMENTS

Shop Problems	88
Patents	89
New Equipment and Supplies	90
Manufacturers' Literature	94
Communications	95
Associations and Societies	96
Personals	97
Business Items	98
Supply Prices	101
Post Scripts	40

METAL FINISHING (formerly Metal Industry) has been the leading publication since 1903 in the field of metal preparation, electroplating and coating.

Specifications

Given above are specifications for one grade of tertiary amyl alcohol and one grade of fusel oil. The former is made synthetically from pentane, while the latter is obtained from the fermentation of molasses. Both are commercial products used as solvents in the finishing industry. The tertiary amyl alcohol contains small amounts of other amyl alcohol isomers. The fusel oil is predominantly primary isoamyl alcohol with primary active amyl alcohol and small amounts of lower boiling isomers.

Uses

The amyl alcohols find many and diversified applications in industry, medicine and science. In the field of organic finishing the amyl alcohols are important solvents. Tertiary amyl alcohol and refined fusel oil are especially useful. Good resin solvents, they possess good blending properties, promote good flow and impart gloss. While not solvents for nitrocellulose, they are latent solvents. The acetic acid esters of these materials are excellent solvents.

Other applications of the amyl alcohols are: primary amyl alcohol as a photographic chemical; tertiary amyl alcohol as a constituent of dry cleaning fluids; in dyeing textiles; in the vulcanization of rubber; as constituents of fruit essences and perfume preparations; in the separation of mineral ore from gangue; in the synthesis of organic chemicals and pharmaceutical compounds such as methyl propyl ketone, an ethyl alcohol denaturant; amyl nitrite, used for the relief of angina pectoris; and amyl barbitol, an important sedative.

Paint

U. S. Pat. 2,262,174 G. Flanagan, Jr., assignor of one-third to E. L. Gruber, Nov. 11, 1941. A paint composition comprising 53% volatile matter consisting of 55 parts water and 45 parts alcohol, and 47% non-volatile matter consisting of 35 parts shellac resin, 8 parts casein, 12 parts zinc sulfide, 5 parts calcium carbonate and 40 parts siliceous extender.

WALKER'S

Finishes to Fit the Product

Zinc Chromate Production Primers, Fillers, Surfacers & Undercoats, Short High Bake Enamels, Chlorinated Rubber Enamels, Rapid Drying Synthetic Enamels, Lacquers and Enamels for all Surfaces, Wrinkle Enamels and Novelty Finishes.

H.V. WALKER CO.
MAKERS OF FINE FINISHES
ELIZABETH, N.J.

New Equipment

Drum and Barrel Carrier

Ernst Magic Carrier Sales Co., 1456 Jefferson Ave., Buffalo, N. Y., have added to their line a new model drum and barrel carrier. This model was designed and constructed for handling litherage drums, which are principally used as containers of heavy materials.



Drum and barrel carrier

It is stated that one man using only one hand can handle the drum where several men were formerly employed, and in addition accidents common to handling loaded containers are prevented by the simple lifting device and self-balancing design.

The small sized model has a capacity up to 600 lb. and other carriers are available with capacities up to 1500 lb.

Life Test on Spray Nozzle

"How long will a Milburn needle and nozzle remain in operating condition?"

This question has been asked by dozens of prospective spray gun customers, and in order to establish a satisfactory reply, the Engineering Department of the Alexander Milburn Company, Baltimore, conducted a test.

A Type OM Gun was equipped with a #53 stainless steel nozzle and needle, and then attached to an air motor. A counter was applied, and over a period of 32 days, the gun was operated 817,081 times. At the conclusion of the run, the needle and nozzle were found to be in perfect condition.

This company offers a chart showing the various head and nozzle assemblies for all types of materials sprayed by Milburn siphon and pressure-feed guns. For a copy of this chart, write the Alexander Milburn Co., 1493 W. Baltimore St., Baltimore, Maryland.

U. S. Government Finishes

Roxalin Flexible Lacquer Co., Elizabeth, N. J., have recently issued bulletins describing four products to meet Government Specifications. These materials are: "Quick Drying Metal Primer" (lacquer type) to meet U. S. Army Specification 3-165-A., "Quick Drying Pyroxylin Surfacers" to meet U. S. Quartermaster Corps Tentative Specification ES-347, "Lustreless Coronado Tan Synthetic Enamel" to meet U.S.Q.M.C. Tentative Spec. E.S. 680, and "Olive Drab Lacquer" to meet U. S. Quartermaster Corps Specification ES-349. Important information on these products is given, such as uses, extent of thinning, application of the material, film thickness and drying properties.

KIRKER
INDUSTRIAL FINISHES
100% Availability
Industrial Lacquers and
Enamels
For Fine Finishes
SEE KIRKER
Kirker Chemical Corporation
PATERSON NEW JERSEY

Founded as METAL INDUSTRY,
January, 1903 by
PALMER H. LANGDON
1868-1935

METAL FINISHING

VOLUME 40

FEBRUARY 1942

NUMBER 2

Publication Office:
116 John Street, New York



L. H. LANGDON
Publisher

THOMAS A. TRUMBOUR
Business Manager

DR. WALTER R. MEYER
Editor

PALMER H. LANGDON
Assistant Editor

JOAN TRUMBOUR
Advertising Manager



PUBLISHED MONTHLY—Copyright 1942
by The Metal Industry Publishing Company,
Incorporated, 116 John St., New York,
N. Y. Entered February 25, 1903, at New
York, N. Y., as second class matter under
Act of Congress, March 3, 1879. Re-
entered as second class matter June 13,
1940, at the post office at New York,
N. Y., under the Act of March 3, 1879.

SUBSCRIPTION PRICES: United States,
\$2.00 per year; Canada, \$2.50 per year
(includes 50c exchange and tax). Foreign
\$5.00. Single copies 25c. Please remit by
check or money order; cash should be
registered.

ADVERTISING RATES on application.
Forms close the first of the month. Adver-
tising copy should be mailed in time to
reach us on or before the 20th of the pre-
ceding month.

METAL FINISHING reserves the right to
investigate all products offered for adver-
tisement, to refuse advertising considered
unsuitable and to edit advertising copy when
necessary.

CONTENTS

Editorial	67
Defense Highlights	68
The Chrome-Hardening of Cylinder Bores—By H. Van der Horst	69
The Electrodeposition of Silver from Thiosulphate Solutions—By Robert Weiner	74
Electrolytic Zinc Coated Wire—By L. H. Winkler	76
Magnesium Alloy Processing—By James P. ApRoberts	84
Organic Finishing Section	
Anodic Treatment of Aluminum in the Chromic Acid Bath—By O. F. Tarr, Marc Darrin and L. G. Tubbs	106
Finishing of Washing Machines—By Carleton Cleveland	112

DEPARTMENTS

Shop Problems	88
Patents	89
New Equipment and Supplies	90
Manufacturers' Literature	94
Communications	95
Associations and Societies	96
Personals	97
Business Items	98
Supply Prices	101
Post Scripts	40

METAL FINISHING (formerly Metal Industry) has been the leading publication
since 1903 in the field of metal preparation, electroplating and coating.



Your War Production Contracts Require Anodizing or Plating Equipment

Call a
LASALCO ENGINEER!

★ Lasalco engineers have installed anodizing and plating equipment for some of the largest manufacturers taking part in our vast war industries. Aircraft plants, shell and cartridge manufacturers, machine tool builders, and many others are represented, including both primary and sub-contractors.

A Lasalco engineer is a practical man. He knows how to lick a problem, do it fast, and get it done *right* the first time. He has worked with hundreds of platers and finishers and has solved many of their problems. He has probably solved problems that are similar to yours—that's why his experience can be so valuable to you.

To back him up in his recommendations, the Lasalco engineer has at his command the complete line of dependable Lasalco equipment and supplies. Thorough investigation of your requirements plus the ingenuity of the Lasalco engineer makes it possible for him to solve your individual problem, whether it requires a single unit or a complete plant layout. Lasalco equipment costs less to maintain and operate, is easier to control, and is more practical because of its simple construction.

A consultation with a Lasalco engineer costs you nothing. It may speed up your production and reduce your costs. Call him in. Your inquiry will receive immediate attention.

LASALCO, INC.

2818-38 LA SALLE STREET

ST. LOUIS, MISSOURI

Platinum Metals Important in War Program

THE industrial use of platinum increased greatly in 1941 and more platinum was used for industrial products than for jewelry. Fortunately, the Allied nations have almost all of the world's sources and supplies of platinum.

Platinum is important as a catalyst in producing nitric acid and much of the contact process sulphuric acid. Palladium is being used on an increasing scale as a catalyst in the hydrogenation of organic compounds. Platinum is used in dies for extruding molten glass and rayon. It is used as insoluble anodes in electrochemical production of perchlorates and persulphuric acid.

Electrical contacts of platinum metal alloys are required in the modern electrical instruments and equipment used by our fighting forces and in our huge industrial efforts. Contributing also to the current high production rate of industry are the numerous thermocouples of platinum or platinum-rhodium alloy used in temperature control and other instruments.

For dental purposes, the consumption of platinum and palladium as alloying elements with gold has shown a marked increase. This was particularly so with respect to palladium, which is employed because of the superior tarnish resistance and performance which it contributes to the gold alloy.

In jewelry, ruthenium-platinum alloys are replacing iridium-platinum alloys, because iridium is being conserved for war work under an OPM order prohibiting its use in the manufacture of jewelry. Ruthenium-platinum alloys are adaptable to jewelry without the necessity of experimentation and are available at lower cost than iridium alloys. The higher taxes recently imposed on jewelry have increased interest in the lower cost palladium alloys and there is a growing acceptance of ruthenium-palladium alloys in this field. Ruthenium, like iridium, is an effective hardening agent for both platinum and palladium.

With the exception of iridium, prices for the platinum metals remained practically unchanged during 1941. Iridium, which was quoted at \$275 per ounce at the beginning of 1941, dropped to \$175 an ounce in February and remained at approximately that figure during the remainder of the year. Platinum was quoted from \$36 to \$38 per ounce throughout the year, against a range of \$36 to \$40 in 1940. Palladium, at \$24 per ounce, has remained stable in price since 1935. Rhodium continued to be quoted at \$125 per ounce, the same quotation prevailing since 1937. At \$35 to \$40 an ounce, there has been no change in the price range of ruthenium since 1938.

Poisoning from Cadmium Plate

CASES of poisoning from cadmium plated articles used as containers for food have been reported recently, and these will be discussed in the March issue of Metal Finishing. Most of the cases have occurred when citrus juices came in contact with the cadmium, such as in making lemonade, fruit gelatin or frozen ices. The cadmium plated containers such as pitchers and refrigerator ice cube trays were all replated with cadmium and not cadmium plated by the manufacturer.

Cadmium should not be used to plate any article that comes in contact with food or for

prolonged periods with the body such as for jewelry. Systemic effects from as little as 15 p.p.m. of cadmium (0.015 g./l.) have been observed and the ingestion of fluids with as low as 67 p.p.m. of cadmium has resulted in violent acute gastritis with nausea, cramps and diarrhea.

Articles such as meat grinders, food choppers, meat hooks, pitchers, refrigerator trays, cutlery, smoking trays should be watched particularly. Refinishing shops should refuse to cadmium plate articles for holding food and should warn the prospective customer of the danger of cadmium on food containers.



Defense Highlights



Another conservation order serious to the metal working field is that of Conservation Order M-38-c restricting the use of lead. After April 1, 1942, lead cannot be used in automobile body solder, ballast in boats for pleasure, building supplies, regalia, badges, emblems, statuary and art goods, toys, clocks, golf clubs.

No restriction has been placed on lead for corrosion protection, anodes and cathodes for electroplating, heat treating baths, bearings, fire apparatus, insecticides, solder, pigments and driers.

The price ceiling on used steel drums and barrels has been made \$1.25 when sold to any person and is not just applicable when sold direct to user.

An important change in PD-1 and PD-3 forms became effective Feb. 2, 1942. Simplification of the process of extending preference ratings will help to speed the flow of war materials to manufacturers.

Maximum prices on both primary and secondary cadmium were set by Leon Henderson on Jan. 19, 1942. Speculation had made the price for secondary cadmium far beyond that of primary cadmium. Maximum prices set are 90c a lb., delivered buyer's plant for sticks, and 95c a lb. for anodes and special shapes.

Sodium nitrate was placed under a complete allocations system on February 1, 1942. It is used largely as a fertilizer, for explosives manufacturing, in meat curing and preserving. It is used by the finishing industry in chemical blackening baths for steel, in silver plating and in bright dips. About 70% of the U. S. sodium nitrate requirements are imported from South America. Allocations will be carried out under General Preference Order M-62.

Radio receivers, phonograph and radio phonograph production was ordered cut to more than 40% below the monthly output of the first 9 months of 1941.

The usage of mercury was curtailed on Jan. 26, 1942 by Conservation Order M-78.

The free sale of batteries or spark plugs for replacement purposes for automobiles or trucks will not be halted according to Leon Henderson. The lead in worn-out batteries has a high reclaim value and almost 85% of the lead can be reclaimed.

The slab zinc production in 1941 was 864,000 tons as compared with 706,100 tons in 1940 and approximately 600,000 tons in 1939. Zinc for hot galvanizing reached an all-time peak in 1941 with a rate of well over 300,000 tons per year for the last three months of 1941. The use of zinc in brass broke all records but the use of

zinc base die castings decreased, due to restrictions on consumer goods.

Price ceilings were recently set on lithopone, carbon tetrachloride and oxalic acid, all of which are used in the finishing industry. Lithopone is used as a pigment in the manufacture of wall paints, lacquers, enamels, oilcloth and linoleum as well as in the rubber industry. A maximum price of \$.0425 per lb. for the normal grade delivered in bags in the Eastern Territory was set. Maximum prices for carbon tetrachloride have been established to cover four zones. The zone 1 price is 73c per gal. for carload lots in 55-gal. drums. Prices set for oxalic acid in less than 10,000 lb. lots range from 12½c to 14c per lb.

Recently published statistics on silver production show that there is still much greater production of silver than consumption. Total silver production in the Western Hemisphere was over 200,000,000 fine ounces in 1941, whereas the total consumption was probably not over 90,000,000 fine ounces, which was almost double the previous high of 41,000,000 ounces.

The eutectic alloy of 2.5% silver and 97.5% lead has been suggested for use as a solder in place of lead-tin alloys. This alloy flows about 580° F.

Maximum prices for hide glue were set on January 27. The maxima set in the price schedules cover 14 grades of hide glue ranging from 14c to 27c in bags of 100 lb. or more.

Sharp curtailments in the quantities of nickel, brass and copper used in the manufacture of non-essential incandescent lamps have been ordered. The lamps are used primarily for Christmas tree decoration, advertising and various display purposes. The curtailment program is designed to save a quarter of a million lbs. of nickel and almost 300,000 lbs. of copper annually.

Tighter restriction on delivery of tin to small users was made in an amendment to the tin order M-43, issued January 14, 1942. The original order permitted the delivery of 5-ton lots to regular customers monthly without specific authorization by the Director of Priorities. The amendment cuts this amount to three-ton lots, provides that the customer cannot receive more than five tons per month from all suppliers, and makes the customer file with his purchase order a certificate of compliance.

The use of silver in bus bars has been suggested to replace copper bus bars in Government-owned power plants or even with private companies so that thousands of tons of high purity copper could be released for war purposes.

The Chrome-Hardening of Cylinder Bores[†]

BY H. VAN DER HORST

*President, Van der Horst Corp. of America
Olean, N. Y.*

THE purpose of chrome-hardening cylinders is to bring about a reduction in the wear of cylinders, piston rings, and piston-ring grooves. This paper reviews the ways in which the application of chromium metal on the cylinder bore affects lubrication and choice of fuel. It further deals with the method of application, that is, proper bonding to the base material and the properties of chromium metal as they are good or bad for this purpose.

Wear of some of the most important parts of the engine, such as cylinders, rings, crankshafts, and ring grooves, has been a topic of keen interest to many engineers, particularly when the output of engines of a certain size and weight is stepped up from time to time. The effect of wear in two-stroke-cycle Diesel engines is of a more serious nature than in the four-stroke-cycle engine, and consequently a comparatively small amount of wear in the former may cause trouble. The reasons may be found in the increased heat flow and in the totally different lubricating conditions, because there is no lubricating stroke between the firing strokes.

Causes of Cylinder Wear

The causes of cylinder wear have been the subject of many disputes, and considerable research work has been done to determine how much corrosion, abrasive matter, lubrication conditions, overloading the engine, idling the engine, bad combustion, overcooling, overheating, the choice of fuel, of lubricating oil, engine design, and other factors cause wear, and to what extent such factors do so. Some of the possibilities mentioned only lead up to others; overcooling will lead to corrosion, poor combustion to both corrosion and carbonization. Some experienced engineers assert that corrosion is the only factor of wear. But in such cases, what is to be said of engines that run under conditions where sand dust or other dust can hardly be removed by filtering? Certainly such engines wear very badly, and one would assume that such wear is of an abrasive character.

Suspended matter, in the fuel or in the air, such as sand or dirt of any kind, naturally affects the wear on cylinders. Thus careful filtering of the fuel is extremely important in Diesel engines to prevent trouble with the pumps, but effective filters will take care of this difficulty. Under certain conditions, especially when the engines operate in dust-laden air, filtering the air becomes necessary.

Another factor that can affect wear is suspended water, particularly salt water, if as much as 1 to 5 per cent is



H. Van der Horst

present. Water can be taken in either by the air or the fuel, but under the usual specifications for fuel, the amount of water is too small to influence wear, especially in comparison with the amount of water which is taken in with air and generated by combustion. However, water is more likely to be introduced when water-cooled pistons are used because then there is the possibility of leakage. The action of suspended water on the cylinders must be considered as corrosive.

The sulphur content of fuel does not become an important factor in wear until it reaches 1 per cent, but once it exceeds 2 per cent its effect becomes distinctly noticeable. This action must also be considered as corrosion. Even in such cases, however, exceptionally rapid wear should not always be attributed to high sulphur content; the heavier fuels which have a high sulphur content also have high viscosity, high Conradson value, and measurable ash content.

In many instances it has been proved that the use of a heavy fuel, or "boiler oil," affects the rate of wear more than anything else. This reaction between fuel and engine is probably due to incomplete combustion, but its mechanism is not yet clearly understood. Attempts to correlate this phenomenon with certain analytical data on the fuel have not been completely successful, but it would seem that usually a high Conradson carbon value will result in a high

[†] Presented Nov. 5, 1941 at the West Coast Transportation and Maintenance Engineering Meeting of Society of Automotive Engineers, San Francisco, Cal.

rate of wear. Conradson figures of 2 to 3 per cent show a definite influence in low-speed engines. However, in several cases Conradson carbon figures between only 1 and 2 per cent have caused a noticeable increase in wear in high-speed engines of 800 r.p.m. and more. The important conclusion to be drawn from this is that unsatisfactory combustion of a fuel containing no sulphur at all can cause more wear than effective combustion of a fuel containing more than 2 per cent sulphur.

Tests on Marine Engines

A few years ago a test, with the most striking results, made in the Delft laboratories of the Royal Dutch Shell, showed the effects of a heavy fuel on wear on cast iron and on a chrome-hardened bore. A 200-hr. run was made with an engine under very severe load conditions, that is, 120-125 psi imep, with varying cooling water temperatures, on fuels ranging from light distillate with 0.75 per cent sulphur up to boiler fuel with a viscosity of 4000 in. Redwood I at 100° F., 10-12 per cent Conradson carbon, 2.5 per cent sulphur, and 0.1 per cent ash.

Despite the heavy load, the severe conditions, and the worst fuel, the results were astonishing:

Cylinder wear on alloyed cast-iron bore	0.040 in. per 1000 hr.
Cylinder wear on chrome-plated bore	0.004 in. per 1000 hr.
Increase in ring gap on cast-iron bore	0.160 in. per 200 hr.
Increase in ring gap on chrome-plated bore	0.004 in. per 200 hr.

They parallel those obtained in certain Dutch ships equipped with two-stroke engines and using the cheapest possible fuels.

But why cannot this problem of the cause of cylinder wear be approached from an entirely different angle? For

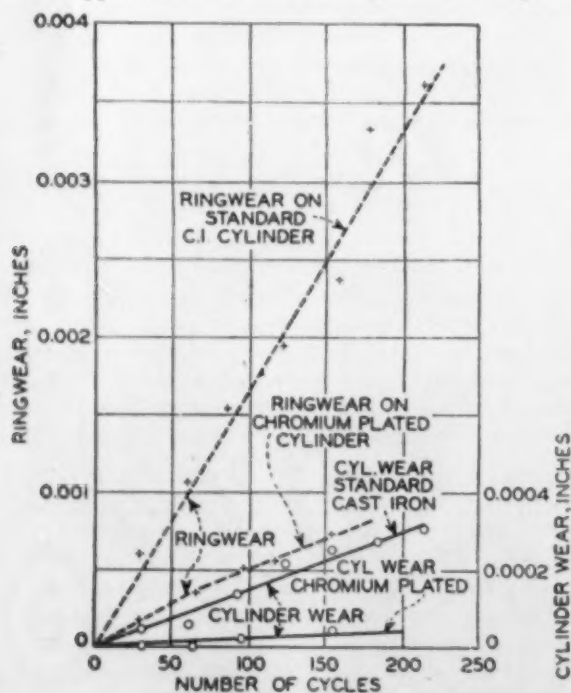


Fig. 1. Cylinder wear test conducted by the Institution of Automobile Engineers (British). (The operating cycle involves 5 min. idling, 10 min. under power, followed by 15 min. cooling to about 50°F.).

example: Create conditions under which cylinder wear is reduced to a considerable extent under all circumstances and then find out in what way such new conditions have affected the engine. Application of chromium will do this; there is no doubt that a good sound coating of chromium reduces wear to an amazing extent. Fig. 1 shows the results obtained some six years ago in the laboratories of The Institution of Automobile Engineers in London. The wear of the chrome bore is about one-seventh of the wear of the cast-iron bore. It is of particular interest to note that the wear of the top ring running in the chrome bore is about one-fourth of the wear of the top ring running in the cast-iron bore. Both rings were ordinary cast-iron rings. A resistance to wear of 15 to 1 is not unusual. At the same time, ring wear is reduced to one-fourth to one-fortieth of the previous average and groove wear is appreciably decreased.

For many years engines with chrome-hardened cylinders and with plain cylinders, running under various conditions, have been closely watched. Some of them were experimental engines run for the sole purpose of determining wear, the factors that cause wear, and means that may lead to resistance to wear. Hundreds of engines in ships or out in the field have been inspected. After all there are now well over a hundred thousand engines running, chiefly Diesel, with chrome-hardened bores, so there is plenty of material from which to draw conclusions.

Returning to the list of probable causes of wear, the chrome-hardened bore has the following effects on some of these factors.

Corrosion-Abrasive Wear

There is hardly a better condition for corrosion—or should it be called worse?—than the two-stroke-cycle engine idling or with a little load. Add to this the use of a heavy fuel and some leaking of water into the cylinder, and the stage is set. A ship with a two-stroke double-acting engine of well-known European make was inspected by some engineers of the Delft laboratories of the Shell group. (She is at the bottom of the English Channel now.) The first thing discovered was that the dirty cylinder wall, as taken from the engine, could be washed clean with cold water. The analysis of the substance scraped off the cylinder wall showed incredible results, the largest content by far being sulphate of iron. Many more large ship Diesel engines have been inspected, and the so-called oil on the cylinder wall analyzed; 3 to 4 per cent of free sulphuric acid is nothing unusual. The application of chromium in such cases helps considerably, on the average reducing the wear to one fifth, and yet this is the least favorable result. The conclusion is that chromium corrodes too, but at a rate of only about one fourth that of alloyed cast iron.

With abrasive wear the application of chromium is far more effective, reducing it one fifteenth to one fortieth. A good example of mainly abrasive wear is found in a report on cylinder wear of 2-RBL engine No. 26060 fitted with chrome-hardened cylinders and 2-RBL engine No. 27004 fitted with nitrided liners, both at Messrs. Boams' Sand Works, King's Lynn, England. The test was made on a Dorman-Ricardo high-speed Diesel engine. The engine with chrome-hardened bores had first run for 1500 hr. in the plant driving a shaft, during which time there was no cylinder wear at all. The wear after 1300 hours' run of both engines is recorded in Table 1.

Table 1. Cylinder Diameters of Engines Nos. 26060 and 27004

(Standard size of bore, 4.725 in. A-B is thrust and antithrust; C-D is in line with crankshaft)

Engine No. 26060 With Chrome Bores

No. 1 Bore			No. 2 Bore	
Diam.	Diam.	Distance from	Diam.	Diam.
A-B,	C-D,	Top of Bore,	A-B,	C-D,
in.	in.	in.	in.	in.
4.7265	4.726	5/8	4.726	4.7255
4.725	4.725	2	4.725	4.725
4.725	4.725	3 1/2	4.725	4.725
4.725	4.725	5	4.725	4.725

Both bores were in excellent condition. Slight wear had taken place at top of ring travel, but did not extend for more than 1/4 in. down the bore, otherwise the cylinder block was as good as when originally fitted.

Pistons. Both pistons were in very good condition, no excessive wear had taken place and the diameter was standard. No. 1 groove had worn sideways approximately 0.002 in.; all other grooves were not worn.

Rings. Rings were dismantled from the pistons and tested in bores for gap. No. 1 rings had gap of 0.015 in. as compared with the original gap when fitted of 0.010 to 0.012 in. This proves that very little wear had taken place on the diameter of the ring, but 0.001 in. wear had taken place sideways. The remaining rings showed no wear in respect to either the gap or the diameter.

Table 2. Engine No. 27004 With Nitrided Bores

No. 1 Bore		No. 2 Bore	
Diam.	Diam.	Diam.	Diam.
A-B,	C-D,	A-B,	C-D,
in.	in.	in.	in.
4.732	4.737	4.730	4.735

It will be seen that No. 1 chrome bore is seven and a half times better for wear than No. 1 nitrided bore, and chrome bore No. 2 is ten times better than nitrided bore No. 2.

Fig. 2 refers to a series of tests with Lister Diesel engines, 1000 r.p.m., in which three runs of 3000 hr. and over on chrome-hardened bores are compared with one engine fitted with a nitrided liner, one engine fitted with an alloyed cast-iron liner, and one engine fitted with a nitrogen-hardened

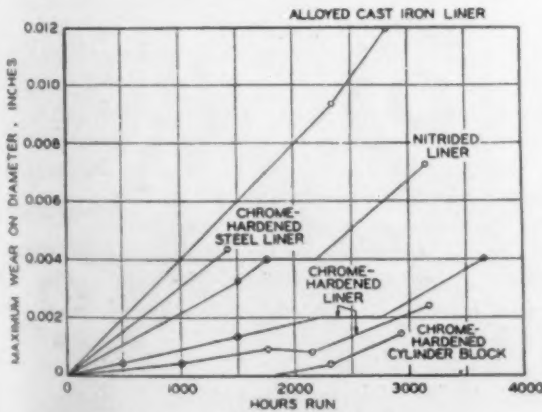


Fig. 2. Comparison of wear of nitrided cast-iron cylinder bore with chrome-plated bore.

steel liner. The wear as compared to the nitrided liner averages one third, as compared to the nitrogen hardened steel liner average one seventh, and as compared to the alloyed cast-iron liner also averages one seventh.

Fig. 3 again shows the wear in a 1000-r.p.m. Lister Diesel engine after a 500-hr. run of a chrome-hardened liner and of a nitrided liner; this time, however, as the wear occurs as measured from the top of the cylinder. The two bulges show that the worst wear takes place at the top end of the top ring travel. The word "Listard" is the trade name of the manufacturers in England of Lister engines for chrome hardening.

Breakdown Test Conducted at Olean, N. Y.

A 14 x 14 in. chrome-hardened power cylinder was run on a single-cylinder test engine at approximately maximum load for a period of 35 hours under conditions intended to promote failure of the chrome plating. The conditions were: (1) Reduction of lubricating-oil supply from the usual 3000 h.p.-hr. per gallon to 6500 h.p.-hr. per gallon (it has been impossible to reduce lubrication below 4000-h.p.-hr. per gallon on plain cast-iron cylinders without scoring); (2) sudden change of cooling-water temperature from 200° F. to 50° F.; and (3) elimination of oil cooling to power piston which allowed the piston to seize the cylinder.

The chrome-hardened surface was not damaged by any of these conditions (except in the case of piston seizure), indicating that the chrome hardening provided a better running surface than plain cast iron. When the piston seized, metal was torn off the piston and built up on the cylinder walls at the points of greatest seizure. This did not indicate failure of the chrome-hardened surface since the chrome was not torn off the cylinder.

Rate of wear on the chrome-hardened surface was not determined since the test was carried out over a short interval of time.

Summary of Tests

The tests were run on a two-cylinder angle engine equipped with one power cylinder. The engine was loaded by using a 29 x 14 in. type V.T.R. compressor cylinder. A 12 x 15 in. Roots' blower was used to furnish scavenging air for the engine. All tests were made at 300 r.p.m. with a load of approximately 100 imep.

After running the engine for about four hours with the lubricator adjusted to 3000 h.p.-hr. per gal., the cylinder was examined and found to be in perfect condition. The lubricator was then adjusted to 6500 h.p.-hr. per gal. and engine ran five hours at maximum load. Inspection of the cylinder showed it to be in perfect condition. The

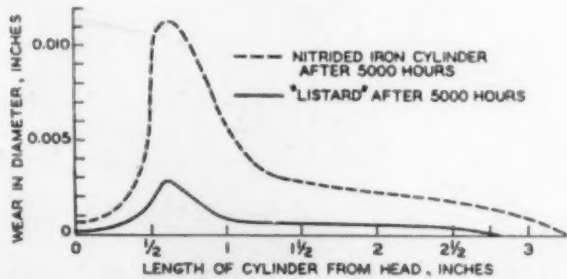


Fig. 3. Comparisons of wear of various cylinder bores.

engine was then operated for approximately three hours, during which time the water temperature was held close to 200° F., cold water of about 50° F. was turned into the cylinder, and the outlet temperature was dropped to 60° F. as soon as possible. Inspection of the cylinder still showed it to be in perfect condition. Following these tests the engine ran approximately 20 hours longer at maximum load while other work was being done on the engine. The cylinder had a streak in it one inch wide that extended down to the bottom of the ring travel. This mark on the cylinder looked a good deal worse than it felt and undoubtedly would never cause any trouble.

For the final test of the cylinder, the oil cooling of the piston was stopped with the intention of allowing the piston to seize. The engine ran at maximum load for approximately two hours before the piston seized and stopped the engine. The cylinder was then removed from the engine and examined. There were two places about six inches below the ports where cast iron from the piston had built up, but the rest of the cylinder looked very good, while the piston was scored nearly all the way around the circumference.

Probably one of the longest runs of an engine (which has been carefully checked) is the one in a trawler fishing from the North Sea to Iceland. By the summer of 1939 this engine fitted with chrome-hardened liners had seen over 40,000 hours of service. The liners in this four-stroke-cycle engine of 11 in. bore used to wear badly, about 0.014 in. per 1000 hours, probably due to so much idling of the engine and cooling at full capacity which reduced the cooling-water outlet temperature to no more than 40 to 50° F. It was for this reason that the engineering firm who had built the engine chose to replace the cast-iron liners with chrome-hardened liners.

The thickness of the chrome layer applied was only 0.0055 in., or 0.011 in. on the diameter. The wear figures of two of the four cylinders are as follows:

After 13,000 hr., 0.003 in. on cylinder No. 2.

After 26,000 hr., 0.0052 in. on cylinder No. 2.

After 15,000 hr., 0.0068 in. on cylinder No. 4.

After 28,400 hr., 0.015 in. on cylinder No. 4.

By this time the chrome in No. 4 cylinder was worn through on one place, but the liner was left in the engine.

Application of Chromium

The application of chromium is not an easy job. It has taken quite a few years to develop it and there have been many failures, but it is through trial and error that a process proves itself.

The process must meet certain fundamentals:

1. The electrolytic coating must adhere perfectly.
2. The thickness of the coating must, within limits, be equal all around and from top to bottom.
3. There must be no tiny ridges for the piston or the rings to run against.
4. The ordinary bright, dense coating of chromium is not suitable; it does not hold lubricating oil.
5. In order to hold oil, it is essential that the chromium be very porous.

Each of those fundamentals is very important. They are considered in detail as follows:

The necessity for perfect adherence is so obvious that it hardly needs to be emphasized. With ordinary good workmanship it is not difficult to achieve. Proper cleaning and

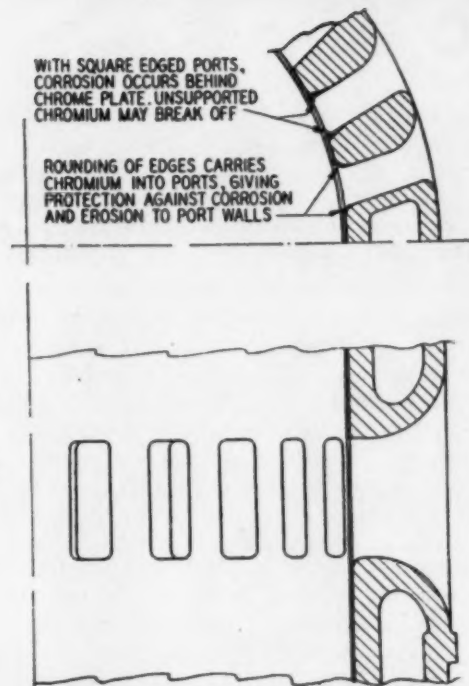


Fig. 4. Treatment of ports of cylinder liners for chromium application.

etching of the cylinder wall together with proper tooling will always give a good adherence. Anodes are cast and machined, and fixtures made to center the anodes, as described in United States Patent No. 2,048,578.

Small cylinders or blocks are always arranged four to ten in one fixture if electroplating is done on a production basis; large cylinders of, say, 20 in. bore and over are treated one at a time.

A variation in cast iron may necessitate a variation in processing, particularly in timing, but that has to be discovered in each case. More difficult are large cylinders of 20 in. bore and over, for several reasons. The surface structure of the cast iron may vary along the cylinder from top to bottom, hence—supposing such a variation could be traced—which it cannot—the processing ought to vary on one cylinder; but this is not feasible. The machining of such cylinders is never as accurate or as good as on small cylinders, and this automatically varies the processing. The usual method of machining the bores of large liners is not sufficient for chrome hardening. A ground or honed finish is required. Ports in two-stroke-cycle engines are always difficult. The fact that a smooth honed surface and a rough cast surface adjoin demands a lot of the art. The edges of the ports should be rounded off so as to plate a little inside the ports.

In this connection, the following experience has been obtained: A two-stroke-cycle test engine with a chrome-hardened cylinder running at full load had been plated without rounding off the edges of the ports so that the coating of chromium ended abruptly from ribs between ports to inside ports. See Fig. 4. After a 2400-hr. run, it was found that there were round bare spots where the chromium had disappeared at the corners of the ports in the direction of the air flow. What had happened? Corrosion had taken place, gradually and very slowly undererating the iron, so naturally the chromium under the full ring pressure had broken down particle by particle. The only way to prevent this is to round off the edges allowing chromium to be plated inside.

The fundamental necessity for equal thickness is also obvious. If the thickness is not equal, the bore cannot be honed clean and the rings and piston will come in contact with the rough chromium of some 1400 Brinell hardness and will abrade rapidly. Equal thickness is obtained by

making suitable fixtures, centering the anodes well, and insulating those parts that should have no coating. The anode must be tapered in such a way that the lower end is slightly smaller in diameter than the upper end. This serves to counteract a tendency to deposit more chromium in the end of the bore that is down in the solution. Depositing inside a bore, there is a tendency for the chromium to taper off for the last $\frac{3}{8}$ in. at top and bottom of bore. In most engines the tapering off at the bottom does not matter, but it cannot be allowed to taper off at the top. However, an extension to the bore takes care of this. It takes practice to arrive at the proper technique of depositing just enough chromium, i.e., from 0.002 to 0.004" minus on the diameter measured on the rough so as to allow for honing to size.

The thickness of chromium required varies from 0.006" to 0.040" as measured on the diameter. In practically all the smaller engines of, say, under 6 in. bore, 0.006" to 0.008" is common practice, and this will last the lifetime of the engine. The proper thickness depends upon the conditions under which the engine will run and the expected lifetime of the engine. An automobile engine rarely has a longer life than 2000 running hours, but a large marine Diesel engine is still supposed to be "brand new" after 2000 hours.

The third fundamental is the necessity to avoid ridges. This has been dealt with in the explanation of the necessity for equal thickness. Such ridges may be very small and escape notice, but unfortunately the piston and rings notice them and are scratched by the 1400 Brinell chromium.

The fourth and fifth fundamentals, to the effect that bright dense chromium is not suitable and that in order to hold oil the chromium must be porous, are interesting points. When this process was first being developed some years ago and was applied to high-speed motor-car engines, it soon proved all that had been hoped for it in regard to resistance to wear. At the same time, however, the chromium and the piston skirt nearly always scored. Every precaution had been taken to make a good job of it, and in this effort the cylinders were honed to a high polish at considerable pains. Events proved that this was wrong. A superior oil was used on recommendation of experts but within a few weeks there were twenty-four engines on the test bed, and every one of them scored. At the same time other high-speed engines were performing very well on a very ordinary mineral lubricating oil. These were inspected and it was discovered that the chromium coating on the latter engines was full of little pits.

This led to experiments in an effort to produce a chromium coating that would be the reverse of a dense, highly polished finish. After a long struggle, these experiments led to success in obtaining a very porous coating of chro-

mium, and since then cylinder scoring troubles have ceased. Contrary to a widespread trend of thought in regard to chromium coatings in cylinder bores, a dense, highly polished finish is no good.

In regard to this process it is often asked: What changes to the engine does it involve? Should there be any change in the piston clearance? What piston rings are to be used? What finish should be used on the liner or cylinder? What lubricating oils are to be used?

A short answer to these questions is: No changes at all. However, this is a bit too broad and it is worth while to review these matters.

It has already been mentioned in this paper that the bores should be machined smooth prior to chrome-hardening by means of honing or grinding. The treatment could not be controlled closely enough if they were not. There is no change in the piston clearance and reference is made to the breakdown test at Olean, N. Y., described in this paper. There was no difference in the piston clearance, and yet the engine was not sensitive to reducing the lubrication to half the normal and to very abnormal cooling.

Regarding piston rings, all makes of rings may be used with one definite exception. Chrome-hardened rings should not be run on chrome bores; nor should nitrided rings or other very hard rings be used. Experience shows that chrome-hardened and nitrided rings cause scoring of the bore, the piston, and the rings in a very short time.

Which lubricating oils are to be used may be answered as previously, "Make no change." Superintendent engineers who have had some years' experience with engines fitted with chrome bores have come to the conclusion that the lowest priced oils suited them equally as well as the higher-priced. Experience has shown that any lubricating oil that promotes the varnishing of the bores, the piston, and the rings is definitely bad. It robs the process of one of its main advantages, the huge reduction in ring wear.

Some changes both in design and materials have been made by engine manufacturers applying this process. However, such changes are not a necessity. What happened is that after a year or so of experience, those items in engine design that primarily were intended for wear reduction are discarded. First to be abandoned is the dry sleeve, which is entirely unnecessary and is a nuisance. Next is the use of plain cast iron instead of alloyed irons, resulting in less cost and often in less risk of cracking. The use of nonferrous material of a high thermal conductivity is being considered.

All in all it comes to this, that the process is much more an engineering than a purely electrochemical problem. To conduct its technique, an experienced motor engineer, who would have to learn the electrochemical side of it would be as valuable as an electrochemist who must learn the motor-engineering side of it. There are many difficulties to overcome, but the industry is used to that.

The Electrodeposition of Silver from Thiosulphate Solutions†

BY ROBERT WEINER

German Gold & Silver Refinery Plant at Roessler, Frankfurt a. Main

THE use of thiosulphate as a brightener in cyanide plating baths, especially silver and copper, has been known for a long time. However, the effects of this addition agent are not very pronounced and, therefore, baths to which thiosulphate has been added cannot be regarded as bright plating baths. Moreover, there has been no success in the development of bright silver plating solutions in spite of the great work done on the same. Inasmuch as the potassium cyanide type solution is the one most generally used for silver plating, the attempts concern themselves with additions to, or modifications of this solution to obtain bright coatings. A serious deficiency of the cyanide type solution is the low permissible current density range and it would be valuable to develop a bath that could be operated at higher current densities, and at the same time, give bright coatings. The different investigations¹ made to develop either bright or rapid plating silver solutions, will be discussed only briefly.

Previous Investigations

THE conclusion is drawn by the writer that all attempts to obtain silver solutions capable of depositing brilliant coatings were not wholly successful. However, investigators were successful in obtaining solutions that gave coatings considerably brighter than those obtained from the usual solutions, and these coatings could be easily brought to a high lustre by a light coloring operation. However, in no case were deposits obtained from potassium cyanide solutions that compared favorably in brightness with bright deposits of such metals as chromium, nickel, cadmium and zinc. This lead to the conclusion that the complex cyanide type solution is not suitable for obtaining brilliant silver coatings although, as we know, this type solution is entirely suitable for obtaining uniform matte coatings. Inasmuch as simple non-complex solutions are not suitable for producing good silver coatings, the only approach would be the study of complex solutions other than the cyanide complex. The cyanide solution has the added disadvantage of being highly toxic. Several complex type solutions have been proposed including the iodide,² thiourea³ and thio-cyanate.⁴

Sodium thiosulphate is a well known effective material used in photography for dissolving silver compounds and obviously, therefore, a study of the thiosulphate type solution should be made. There are hardly any references in recent literature on the subject of silver thiosulphate solutions. Perhaps this may be attributed to the fact that

exploratory investigations with thiosulphate solutions did not give encouraging results. A patent of Kodak Pathé⁵ concerns itself with the deposition of silver from thiosulphate solutions, but it is primarily concerned with the electro-winning of silver from such solutions, which for example, are those used as fixing baths in the photographic industry. It accordingly would be of great interest to determine whether thiosulphate could not itself be used as a basis for obtaining a solution that would give outstanding bright coatings.

Experimental

FIRST, a bath was made by dissolving 30 g. of silver chloride (AgCl) and 200 g. of sodium thiosulphate ($\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$) in 1 liter of water. The electrolysis was carried out in rectangular glass vessels of 200 cc. capacity. The electrodes were 40 x 50 mm. and were placed opposite each other in a parallel position on the two narrow ends of the container. The solution was usually not stirred and was operated at room temperature. The anodes were of fine silver, either from rolled silver or freshly electrodeposited silver. Iron, brass and silver sheets were used as cathodes. Silver sheets were used because frequently in practice the silver deposit is made upon a pre-silvered surface (for example, by using a strike solution).

The original solution described previously gave deposits at 0.3 to 0.5 amp./dm² which were matte, yellowish-white and not completely smooth. At higher current densities, entirely unsuitable deposits were obtained. Different inorganic additions, such as for example, ammonium chloride, sodium carbonate, sodium hydroxide, sodium thiocyanate and ammonia, have unfavorable effects and serve generally to impair the coatings. Cyanide, as well as phosphates, on the other hand, slightly improve the coatings. Different organic addition agents, such as for example, Turkey red oil (sulphonated castor oil) and other capillary active substances and colloids gave either bad results or did not improve the working of the solution.

A solution with a higher silver content, namely 30 g./l. of silver as silver chloride dissolved in 200 g./l. of sodium thiosulphate gave about the same results. Similar results were also obtained by lowering the silver content to 15 g./l. In this solution the various addition agents previously mentioned were also ineffective. The following substances gave favorable results when used in the small concentration

† "Die Elektrolytische Abscheidung von Silber aus Thiosulfatlösungen", Zeitschrift für Elektrochemie 45, p. 757 (1939). Translated by Dr. Walter R. Meyer.

of 0.5 g./l.: glue, gelatin, gum arabic and starch. The silver deposits at a current density of 0.5 amp./dm.² (4.7 amp./ft.²) were pure white but not particularly bright, but rather had a silky appearance.

THE thiosulphate content of the solution was then changed and as a starting point in a series of experiments, the smallest amount of sodium thiosulphate necessary to dissolve the silver was used. To do this, silver chloride with a silver equivalent of 40 g. was actively agitated in a 1-liter vessel, and to the suspension was gradually added a solution of sodium thiosulphate until complete dissolving of the silver chloride resulted. To do this, 170 g. of $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$ were required. This calculates to a molecular ratio of about 1 mol of silver chloride to 2 mols of sodium thiosulphate. The solution thus obtained gave brilliant silver deposits at current densities of 0.5 amp./dm.². Brilliant coatings can be obtained from the solution after 1½ hours of electrolysis. The brightness, however, was strongly impaired at current densities of the order of 1 amp./dm.². (9.3 amp./ft.²).

At the anode, there appeared in every case, a thick, brittle layer of dark-brown to black color which gradually exfoliated. Inasmuch as the coating forming on the anode exfoliated at the beginning of the electrolysis, the passage of the current was generally not interfered with at the start of plating, but gradually an adherent layer formed on the anode which almost completely restricted the flow of current. Moderate stirring of the bath or occasional scraping of the anode with a glass rod no longer helped, and in order to overcome this mechanical passivation, the anodes had to be removed for a short time from the solution and the coating removed by strong brushing.

An addition of 5 g./l. of potassium cyanide effected a slight improvement in the condition at the anodes. When 10 g./l. of potassium cyanide were added, a uniform bright yellow colored coating formed. Unfortunately, even the smaller addition of potassium cyanide made the deposits milky, and with 10 g./l. of KCN, the brightness was completely lost and the coating was unsuitable. Even with the addition of colloids and other substances, the usual lustre obtained in cyanide type solutions was not again attained. Baths made initially of silver cyanide in place of silver chloride gave dull coatings and the anodic passivity was likewise not obviated. The overcoming of the passivity of the anode by heating of the electrolyte was likewise impossible because even with heating to only 40° C. (104° F.), the brightness of the deposits was completely lost.

It is interesting that the anodes during the gradual appearance of the anodic phenomenon remained mirror-bright at those spots that remained uncoated, similar to the phenomenon observed in other bright plating solutions when high current densities are used.

IN ADDITION to the anodic passivation phenomenon, the solution mentioned had the added disadvantage of decomposing very quickly. Even during dissolving of the silver chloride in thiosulphate, a dark brown color in the solution frequently appeared as well as the precipitation of silver sulphide. Such baths decomposed later very quickly with the precipitation of silver sulphide and became completely unsuitable for use after a few days. In other cases, the decomposition of solution proceeded, curiously enough, considerably more slowly and the indications were that the

acceleration of the decomposition resulted from the presence of a small trace of nitric acid which was present in the freshly precipitated silver chloride used to make the solution. Baths prepared from silver chloride, carefully washed to remove nitric acid, were generally much more stable, but nevertheless, they still exhibited a peculiar decomposition after standing exposed to the air. This can be accounted for by either the action of the carbon dioxide in the air or an oxidizing effect by the oxygen in the air, or merely by simple decomposition of the silver thiosulphate complex. If the first hypothesis were true, an addition of alkali should effect improvement. The addition of ammonia or caustic soda accomplishes an extraordinary retarding effect on the decomposition of the solution. Additions of reducing agents should overcome the oxidative effect of the air although the thiosulphate in itself already has a reducing effect. Indeed, it was found that additions of sulphite or bisulphite accomplished an excellent stabilization of the bath.

Bisulphite proved to be the most favorable addition after long-time studies. The addition of 20 g./l. of sodium bisulphite, (NaHSO_3) brought the pH to 5.2 which proved to be the most favorable value for the stability of the solution on the one hand, and for the most favorable bright plating range on the other. However, a bath thus stabilized is not always completely stable. After several weeks' standing, a light precipitate of silver sulphide can be seen and judging from the gradual increase in rate of decomposition from the less unstable solutions, this solution in turn may become unusable as a result of an increasing rate of decomposition after a longer period of time. On the other hand, it was observed, that with solutions operated for some time, this decomposition was no longer observed even after standing for several months, exposed to the influence of air and light.

It appears that the electrolysis either destroyed the traces of substances conducive to catalytic decomposition or they were transposed into other substances that hinder the decomposition.

The reaction possibilities of thiosulphate at both the anode and cathode are so numerous that only a partial guess can be made as to the compounds formed that may influence the decomposition of the solution. It would be possible perhaps to determine by means of diaphragms whether the stabilizing compounds are formed at the anode or the cathode.

THE presence of bisulphite unfortunately does not result in a diminution of the anodic passivation effect. On the other hand, however, it fortunately does not have any harmful effect on the appearance of the cathode. Coatings of the usual commercial thickness of, for example, 4 g./dm.², were obtained bright without any other treatment. The solution has another disadvantage besides the anodic passivation phenomenon and that is that the silver coatings obtained may be occasionally brittle and exfoliate from the base metal. It was found out that additions of large concentrations of neutral salts to the solutions favorably affected the solution of the anodes, and in addition, a decrease in the brittleness of the coatings was obtained. Additions of from 50 to 100 g./l. of sodium chloride, sodium sulphate, sodium citrate and sodium acetate were made. In general, these additions improved the ductility of the coat-

(Continued on page 83)

Electrolytic Zinc Coated Wire[†]

BY L. H. WINKLER

*Metallurgical Engineer,
Bethlehem Steel Co., Bethlehem, Pa.*

Introductory

IN this paper we shall describe the electrolytic process of zinc coating wire as developed by the Bethlehem Steel Company, and touch on some of the properties of the product, which we have merchandised under the trade name "Bethanized Wire", and give a few representative applications.

In order to bring out the special qualities of Bethanized wire, it may at times be necessary to draw comparisons between that product and hot galvanized wire. Comparisons are sometimes misunderstood, but we hope that our discussion will not in any way be interpreted as derogatory to hot galvanized wire for those services to which it is particularly well adapted, and where it has already given a very good account of itself in actual usage.

The mechanism of corrosion is so complex that even though the subject has received much study, and many theories of the phenomenon have been advanced, it is probably safe to say that our actual knowledge of the subject has not progressed as far as is desirable. Many attempts have been made to devise laboratory tests which could serve as a basis for evaluating corrosion resistance of various materials under the many and varied conditions which are met in actual service. So far, however, none of these tests have proved to be thoroughly reliable inasmuch as long-time exposure tests under actual service conditions have more frequently reversed the predictions based on such laboratory tests than sustained them. It is for this reason that national engineering societies, notably the American Society for Testing Materials, have undertaken research into this question

of corrosion by elaborate programs of testing at various locations and in various atmospheres under actual exposure conditions. The American Society for Testing Materials, through its Committee A5, has had under way for a number of years a most interesting and valuable series of exposure tests. This work has steadily progressed and there is now available, par-

ticularly on sheets, information of much practical value. Even though the results so far obtained have in many respects reversed previous impressions gained from accelerated laboratory tests, our basic knowledge of materials has been considerably broadened.

FOR five years the Committee has had under way similar exposure tests on wire and wire products at several locations between the Atlantic Seaboard and the Pacific Coast. The samples used in these tests include zinc coated wire having coating weights covering the entire range from the lightest coating made to the heaviest commercial coatings. Doubtless, in a few years we shall realize much valuable information from this commendable and extensive work of the Society.

It is well known that steel exposed to the elements should be protected by some means. Various paints and metallic coatings are used for this purpose. When unprotected steel is exposed to the atmosphere, it rusts. The rapidity of this rusting depends largely upon the atmospheric conditions under which the steel is exposed. If the atmosphere is dry and free from industrial gases, corrosion does not progress rapidly. This accounts for the fact that some of the iron specimens made by the ancients have withstood the actions of the elements for hundreds of years. Those specimens, however, when transferred to a different atmosphere, for example, London, England, showed rapid deterioration in a few years.

[†]A paper presented before the Annual Meeting of the Wire Association at Philadelphia, Pa., October 1941 and reprinted by permission of "Wire & Wire Products".



L. H. WINKLER

University of Missouri, B.S. in M.E., 1907. University of Missouri, Mechanical Engineer, 1909. Engineering Department, Cambria Steel Company at Johnstown, Pennsylvania, 1907-1909. Metallurgical Department, Cambria Steel Company, 1909-1917. Engineer of Tests, Cambria Steel Company, 1917-1928. (The Cambria Steel Company was purchased by the Bethlehem Steel Company in 1923.) Metallurgical Engineer, Bethlehem Steel Company at Bethlehem, Pennsylvania, 1928-19—. Member of the Wire Association, American Petroleum Institute, Iron and Steel Institute (Great Britain), American Society for Testing Materials, and American Society for Metals.

THE BETHANIZING PROCESS

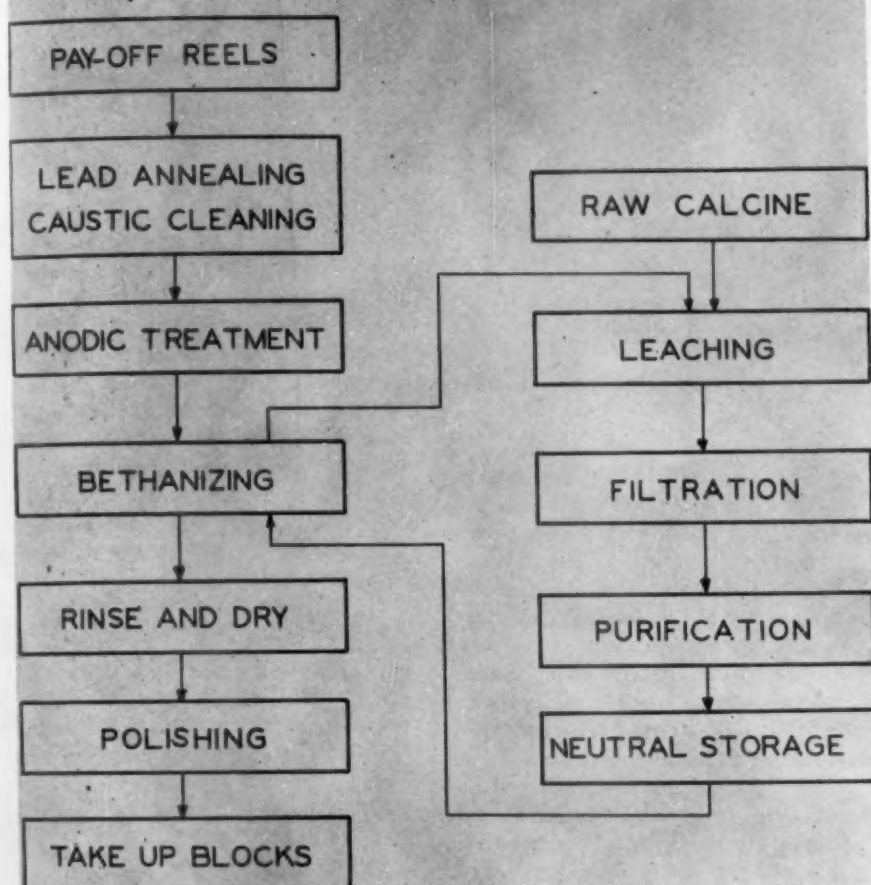


Figure 1. Flow-sheet of the Bethanizing process.

Metallic iron is unstable when exposed to many atmospheric conditions. Iron appears in nature in the form of an oxide which has a chemical composition similar to that of rust; so the film of rust which forms on exposure is simply a case of iron reverting back to its original condition and the only thing that we can do, in our efforts to prolong the life of steel, is to provide means of retarding this action.

In addition to paint as a means of preserving the surface of steel, various metallic coatings have been applied, such as coatings of copper, tin, nickel, chromium, lead and zinc. All of these metals corrode, but their rate of corrosion and the character of the corrosion products differ.

THE most commonly adopted protective coating for steel wire is zinc. Actual long-time exposure tests, which have been conducted up to the present

time, have indicated that the life of zinc coatings is at least proportional to the amount of zinc in ounces per square foot of surface. It is the opinion of some observers that the life of the coating increases in more than direct ratio to the coating weight. But the actual ratio can be determined only by exposure tests such as those which are now being conducted by the American Society for Testing Materials. As the very heavy coatings, which have come into use in recent years, have not been in existence long enough to provide actual data, it has been our policy to base a conservative estimate on indications which have so far resulted from exposure tests of the lighter coating, namely, that the life of a zinc coating is at least proportional to the weight of zinc in ounces per square foot of surface.

Since there appears to be no accelerated tests so far developed which are dependable as a measure of the life of

zinc coatings, apparently the best procedure is to evaluate the zinc coating by the standard A.S.T.M. procedure for determining the actual amount of zinc present in ounces per square foot of surface area and estimate an expected life in a specific location from experience with known coating weights in that location. The Preece test was the first test employed for evaluating zinc coatings, but it has been found less reliable than the standard stripping test described in A.S.T.M. Procedure A90. Unfortunately, the Preece test is based on the rate of solubility of the coating in a copper sulphate solution and it has been found that many factors influence the results. Impurities in the zinc, for example, iron will influence that rate of solubility. As a consequence, where a four immersion Preece test wire would normally be expected to carry at least 0.8 oz. of zinc per square foot of surface, there have been instances where a contaminated coating of zinc would show 5 or 6 immersions when the actual weight of coating did not greatly exceed 0.5 oz. of zinc per square foot of surface; hence it is evident that the Preece test is not a reliable measure of the amount of zinc being furnished. Moreover, there is no evidence to point to any relation between the rate of solubility of a zinc coating in a copper sulphate solution and the behavior of that coating under actual exposure conditions. As a result of all this, many engineers are placing more dependence on the stripping test and less dependence on the Preece test.

Zinc Coating Processes

ON account of the great economic importance of zinc coatings as a protection against the corrosion of steel, a great deal of research and effort has been devoted toward improvement in the quality of those coatings and improvement in the processes for applying them. Until the time the electrolytic methods were fully developed, the most practical means of applying zinc coatings to wire have been the hot galvanizing processes, the procedures of which have also been greatly improved in recent years. We shall, however, confine ourselves to the discussion and the description of the strictly electrolytic method which has been perfected in recent years by the Bethlehem Steel Company and as employed in our wire mills. For a good many

years before the development and application of the Bethanizing process, the zinc coatings applied by the means at our disposal did not have as good mechanical qualities as were needed to keep step with progress in the extending field of application of galvanized steel products.

The need for heavier zinc coatings than those available has become increasingly evident, as has the need for heavy zinc coatings which would withstand the drastic deformations incident to the fabrication of heavily coated wire and sheets. Everyone has experienced the disappointment of zinc coatings flaking off wire and sheets when subjected to drastic forming operations. When wire or sheets had to undergo severe fabrication, it was found expedient to apply only thin coatings of zinc; otherwise the coating would peel off as a result of the forming operations. By means of this new electrolytic process, we are able to apply coating weights covering the full range of zinc coatings beginning with those even lighter than might be applied by the hot galvanizing method up to a coating weight several times as heavy as has been found practical to apply by the hot galvanizing method. In addition to this, owing to the extreme purity of the zinc produced under this process, the coating metal has ductility properties far beyond those that have been customarily associated with zinc. This great ductility, aided by the perfection in the bond between the zinc and the steel, has enabled us to produce wire which will withstand mechanical work to an exceptional degree without damage to the coating resulting from cracking or flaking.

Development of Electrolytic Galvanizing

THE first electrogalvanizing process which has been applied on a large commercial scale seems to have been that developed at the Langbein-Pfannhauser Werke in Germany. It appears that Langbein used a neutral zinc sulphate bath as an electrolyte and plated from zinc anodes at moderate current densities (50 to 100 amperes per square foot). There may have been nothing new about the actual plating process at that time, but Langbein was apparently the first to develop the necessary wire handling methods combined with a more satisfactory cleaning process, thus making possible a commercial scale operation in the pro-

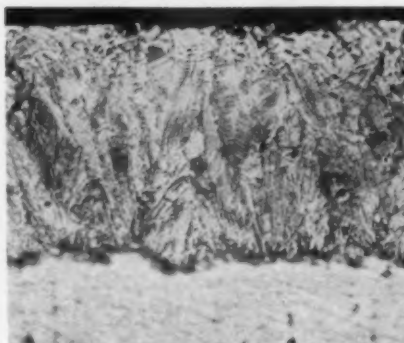


Figure 2. Etched structure of Bethanized coating. No. 6 gauge wire with 3 oz. coating weight. Magnification 500 diameters.

duction of reasonably heavy coating weights.

With certain variations in bath composition and methods of cleaning, essentially similar processes employing soluble zinc anodes have been used in electrogalvanizing plants installed in the United States in the last few years. Prior to the development of the Bethanizing process, it appears these processes were mainly used on narrow strip and the coatings applied were relatively light. Later, however, there has been other equipment built in the United States representing marked improvement over the older electrogalvanizing methods which were their predecessors. By means of this new equipment, heavier coatings can be produced than were formerly possible.

In view of the fact that we have had no experience with the processes employing soluble zinc anodes and know little of the details of the operation of those processes, this paper will be confined to the process used by the Bethlehem Steel Company, in which an insoluble lead-silver anode



Figure 3. Unetched section of Bethanized wire. No. 6 gauge wire with 3 oz. coating weight. Magnification 500 diameters, showing junction of zinc and steel.

is used and in which there is no metallic zinc in the process until it appears as pure virgin zinc on the surface of the wire, as a result of electrolyzing the zinc from the sulphate solution.

The Bethanizing Process

U. C. TANTON developed a method for the extraction of zinc from its ore, combined with the electrodeposition at high current density of that metal in cyclic process. The basis of this process was a leaching of zinc oxide from roasted zinc ore by means of sulphuric acid to form a neutral zinc sulphate solution, the purification of this solution by means of zinc dust, the use of the purified solution as a feed to the zinc depositing cells, and the use of the excess acid regenerated in the cells from the zinc sulphate solution as the leaching medium for the ore.

In the plant at Kellogg, Idaho, Mr. Tanton was the first to produce the so-called 99.99 zinc which due to its purity was found to have valuable properties which are now widely known and extensively used in industry.

In the early stages of his work, Mr. Tanton built a pilot plant in England for depositing zinc directly on wire and other ferrous products. There were a number of reasons why the idea failed to take hold at that time; the principal reason, doubtless, was the fact that industry was not yet ready for this product.

In 1931, Mr. Tanton moved to Baltimore, Maryland, and set up a laboratory with a sizable research staff. In this laboratory, a wire plating unit was built and a fair quantity of wire was plated for tests and exhibit. Bethlehem's decision to acquire rights to the process was based on the performance of this laboratory unit and a pilot unit of production size was built at Sparrows Point, Maryland, in 1932.

After very considerable further development work and numerous rebuildings of this equipment, in January, 1934 it was apparent that enough of the serious difficulties had been overcome to permit the operation of the plant at full capacity and at a reasonable cost per ton of product. For a time the production at Sparrows Point was confined largely to special wires of coating weights ranging from those comparable to charcoal wiped

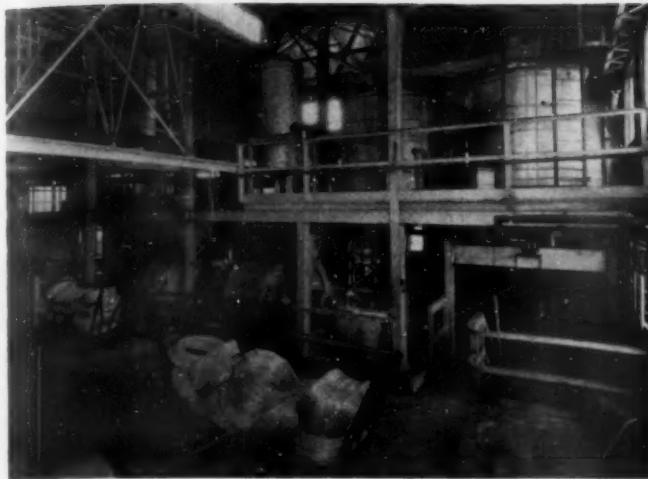


Figure 4. View of leaching plant for preparing pure zinc sulphate electrolyte. Showing leaching vats, purification vats, filters, pumps and storage tanks.



Figure 5. Pay-off reels for carrying wire to be galvanized. Successive coils of wire are electric butt welded into continuous strands.

hot galvanized wire to approximately three times the coating weight obtainable by the hot galvanizing processes. During this period, of course, it was necessary for us to develop a market for the product.

Fortunately, as previously indicated, industry was now ready for this type of commodity and the demand kept pace with our increasing ability to produce this new special type of zinc coated wire. Sufficient progress had been made to justify our company in building a new and larger unit at the Johnstown Plant in 1936. To meet the requirements at that time, two 12-wire cells, 110 feet long, served by a 40,000 ampere generator were built, as compared with the four 55 foot, 8-wire cells at the Sparrows Point Plant served by a 12,500 ampere generator. Since that time extensive additions have been made at Sparrows Point.

Comparing the present process and the equipment with the original, the leaching and plating steps have remained fundamentally the same, but have been improved in detail, and to such an extent that a different order and purity of uniform electrolyte is now available and the quality of the coating has correspondingly improved. Important improvements have also been made in the methods and details employed in the cleaning of the wire preparatory to plating.

THE product of the Bethanizing process, thus developed from the basic methods of Mr. Tainton, is definitely an electrolytic zinc coated wire. Bethanizing is distinct from the older electrogalvanizing processes in that, as already pointed out, no metallic zinc appears in the system until it is elec-

trolyzed from the solution as virgin zinc on the wire as a finished product. This is because the calcined zinc concentrate is the raw material source of the zinc instead of the zinc anode as employed in the older electrogalvanizing methods.

The Bethanized coating differs from the coating produced by the hot dip methods in several important respects. The ductility of the Bethanized zinc coating is perfect, due to the absence of impurities and to the absence of the harder and more brittle zinc-iron alloy which is present when steel is galvanized by the hot dip process. The absence of this zinc-iron alloy and the high purity of the electrolytic zinc provides a ductility of coating which has never before been associated with zinc coatings. As a consequence of the perfect bond resulting from the cleaning methods and the characteristics of

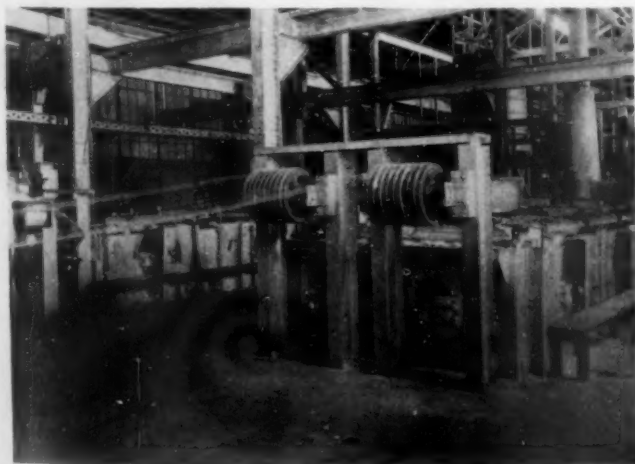


Figure 6. View of caustic soda cell. Continuous strands of wire pass through molten caustic soda electrolytic cleaning cell; the passage of the current is such that the wire is made the cathode.

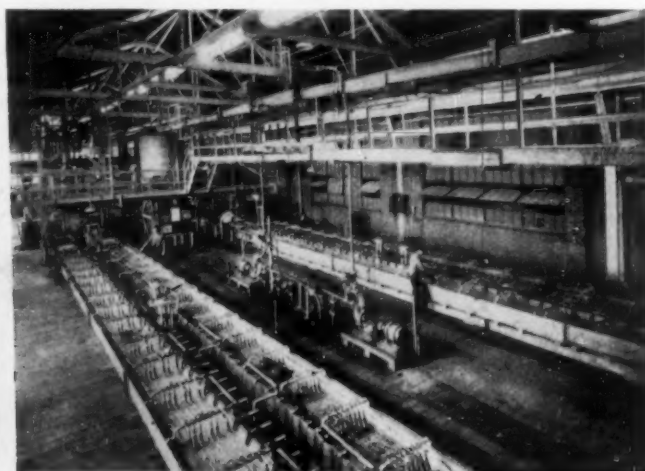


Figure 7. View of plating cells. Each of these four cells carries eight wires. Caustic soda cells and pay-off reels in background.



Figure 8. Close-up view of plating cell.



Figure 9. Burnishing machines for polishing finished Bethanized wire.

the electrolytically deposited zinc, it is possible to employ fabricating operations on extremely heavy coatings that could never before be realized, even including the severe mechanical work involved in very substantial cold drawing subsequent to the Bethanizing operation. Furthermore, by this process, we have found it possible to zinc coat any type of steel wire that demands might indicate as desirable and, by utilizing the full flexibility of the process supplemented by subsequent cold work, obtain physical properties of a much greater range than could be realized by the older hot galvanizing methods. It is apparent that this has opened up a much wider and more diversified field of application for zinc coated wire.

Description of the Process

FOR the sake of a better understanding of the operation of this process, we have prepared a flow-sheet showing the several steps in the process, Figure 1. It will be noted that the unit consists of two principal divisions. Broadly speaking, we have combined a chemical extraction plant with a plating plant.

As stated before, the source of zinc in the plating cells is a purified zinc sulphate solution. This solution is prepared in the leaching plant adjacent to the plating units.

Calcined zinc concentrate is brought into the leaching plant as a raw material. It is dissolved by free sulphuric acid present in the used plating solution, which is returned to the leaching plant from the plating cells, until the resulting solution is nearly neutral.

The iron carried by the ore will precipitate from this approximately neutral solution, but this leaching process requires considerable skill in its execution in order to obtain satisfactory results. The substantial amount of iron that is precipitated in the leaching treatment of the calcine is in a form of a colloidal hydrate that is difficult to filter, and the filterability of which is sensitive to the conditions of its precipitation. The product of the leaching vats is filtered in a large rotating drum or Burt filter. By this means the hydrated iron precipitate, in which is entrapped some of the normal impurities, is separated and discarded. The resultant filtrate is a very concentrated zinc sulphate solution which contains small amounts of impurities not removed by the iron precipitation. By treating this neutral zinc sulphate filtrate with zinc dust, it is possible to remove practically all of the remaining copper, cadmium, antimony, etc., and thus provide the very pure neutral electrolyte as a means of introducing zinc into the electrolytic cells of the process.

THUS, it is apparent that the Bethanizing process comprises two distinct operations in parallel, one for the continuous regeneration of the electroplating solution and the other for the treatment and processing of the wire being plated. By judicious adjustment of the concentrations of the several solutions involved, it is possible to operate the system without alteration of the total solution volume employed.

Before the application of the electro-

lytic zinc coating, the wire is generally annealed and cleaned. The flow-sheet indicates the annealing step employed for the production of soft zinc coated wire. If it should be desirable not to soften the wire to the point of conventional soft galvanized wire, the lead annealing may be bypassed. Thus, we have available a wider range of tempers of the finished wire than we were previously able to realize with our hot galvanizing units. A particular development in this process is the practically simultaneous lead annealing and caustic cleaning operations by passing the wire through molten lead on which lies a covering bath of molten caustic soda. By a suitable arrangement of electrodes the wire is made cathodic in this caustic cell so that nascent sodium is discharged on the wire and a perfect cleaning and oxide reduction operation is performed.

FROM this annealing and cleaning unit the wire travels through a rinse into an acid solution where again it is treated electrolytically; this time, however, the wire is made the anode. By means of these two treatments, the surface of the wire is perfectly clean and prepared to take a tightly adherent coating of electrolytic zinc.

From the anodic treatment cell, the wire passes immediately into the plating cell. The electrolyte in the plating cell is a very high acid solution characterized by high electrochemical efficiency at high current densities. Current densities of the order of 1,000 amperes per square foot are employed. The resultant electrolytic zinc coating

TABLE I

Nominal Diameters and Minimum Weights of Coating for Zinc-Coated Steel Wires

Note: For intermediate sizes of wire in the strand, the weight designations are the same as for the next finer size shown in this table.

Nominal Diameter of Coated Wire in the Strand, Inch	Minimum Weight of Coating, oz. per sq. ft. of uncoated wire surface			
	"Galvanized" ^a	Class A ^b	Class B ^c	Class C ^c
0.041	0.15	0.40	0.80	1.20
0.052	0.15	0.40	0.80	1.20
0.062	0.15	0.50	1.00	1.50
0.065	0.15	0.50	1.00	1.50
0.072	0.15	0.50	1.00	1.50
0.080	0.30	0.60	1.20	1.80
0.093	0.30	0.70	1.40	2.10
0.100	0.30	0.70	1.40	2.10
0.104	0.30	0.80	1.60	2.40
0.109	0.30	0.80	1.60	2.40
0.113	0.30	0.80	1.60	2.40
0.120	0.30	0.85	1.70	2.55
0.125	0.30	0.85	1.70	2.55
0.143	0.40	0.90	1.80	2.70
0.145	0.40	0.90	1.80	2.70
0.150	0.40	0.90	1.80	2.70
0.161	0.40	0.90	1.80	2.70
0.165	0.40	0.90	1.80	2.70
0.177	0.40	0.90	1.80	2.70
0.179	0.40	0.90	1.80	2.70
0.188	0.40	1.00	2.00	3.00
0.200	0.40	1.00	2.00	3.00
0.207	0.40	1.00	2.00	3.00

^a—"Galvanized" coating applies to "Common" strand only.

^b—Class A coating applies to all grades of strand.

Class A, "Extra Galvanized" and "Double Galvanized" are equivalent terms.

^c—Class B and Class C coatings apply to all grades of strand.

TABLE II

Standard Coating Weights Galvanized Manufacturers' Wire

Gage	Single Galvanized	Intermediate Galvanized or Bethanized	Special Galvanized or Bethanized "A"	Bethanized "B" Coating	Bethanized "C" Coating
	Type 1	Type 2	Type 3		
Coarser than 6	.65 oz.	.75 oz.	.90 oz.	1.80 oz.	2.70 oz.
6	.50 oz.	.70 oz.	.90 oz.	1.80 oz.	2.70 oz.
7	.40 oz.	.60 oz.	.80 oz.	1.60 oz.	2.40 oz.
8	.40 oz.	.60 oz.	.80 oz.	1.60 oz.	2.40 oz.
9	.40 oz.	.60 oz.	.80 oz.	1.60 oz.	2.40 oz.
10	.30 oz.	.50 oz.	.80 oz.	1.60 oz.	2.40 oz.
11	.30 oz.	.50 oz.	.80 oz.	1.60 oz.	2.40 oz.
12	.30 oz.	.50 oz.	.80 oz.	1.60 oz.	2.40 oz.
13	.30 oz.	.50 oz.	.70 oz.	1.40 oz.	2.10 oz.
14	.25 oz.	.45 oz.	.65 oz.	1.30 oz.	1.95 oz.
15	.15 oz.	.35 oz.	.50 oz.	1.00 oz.	1.50 oz.
16	.15 oz.	.35 oz.	.50 oz.	1.00 oz.	1.50 oz.
17	.15 oz.	.30 oz.	.40 oz.	.80 oz.	1.20 oz.
18	.15 oz.	.30 oz.	.40 oz.	.80 oz.	1.20 oz.

that is formed has a uniform structure which might be characterized as continuous from the surface of the steel to the outer surface of the coating. In order to show the character of the structure of this zinc coating, we show in Figure 2, at 500 diameter magnification, the structure of a 3 oz. coating. The etchant employed was Palmerton No. 1 reagent. As sometimes happens in order to bring out the structure of the coating in the photomicrograph, the steel base at the junction is somewhat out of focus; the photograph was so taken in order to bring out sharply the orientations in the zinc structure.

In Figure 3, is shown an unetched section at 500 diameters to illustrate the bond between the zinc and the steel base. It is interesting to note how intimately the zinc has been deposited into the microscopic irregularities of the surface. The appearance of the zinc is the result of the polish attack of the dry polishing method and the instantaneous oxidation of the polished zinc surface which shows up very distinctly at these very high magnifications. This coating is a 3 oz. coating on 0.192" diameter wire.

As stated before, insoluble anodes are used in this process, and for this purpose, a special alloy of silver and lead has been found to be most effective. Numerous contactors on the wire provide a means for introducing the necessary current for electrolyzing the zinc from the solution and depositing it upon the wire.

From the electrolytic cell in which the Bethanized coating is applied, the wire is passed through rinsing baths and subsequently polished with a rapidly rotating burnishing machine or, in some cases, by employing a very light draft in a die. The finished product is taken up on blocks similar to those conventionally used in the hot galvanizing process.

Some Current Applications of Bethanized Wire

IT MAY be of interest to say a few words about the applications and utility of this special zinc coated wire. Almost daily there are new demands which the product is filling. The field of application has become very broad indeed, ranging from merchant wire products, such as fence and barb wire and nails and staples formed directly from the Bethanized wire, to unusually high strength galvanized rope and cable wire.



Figure 10. Take up frames of Bethanizing units. These take up blocks are equipped with variable speed control in order to provide the speed required for a given coating weight.

One of the early developments was heavily coated telephone wire and heavily coated strand wire. The demands for these products in heavy zinc coatings has shown a very healthy progress. Obviously with the introduction of these heavier coatings, an extension of the series of coating weights standard in the industry was desirable. For that purpose we chose coating weight requirements of standard specifications in telephone wire and strand wire as our first item. Therefore, our "A" coating was set at the equivalent, from a coating weight standpoint, of charcoal wiped hot galvanized wire. Our next coating weight we named "B" coating which was standardized as twice the coating weight of "A" coating; and the third weight we designated as "C" coating and set it at three times the weight standardized upon for "A" coating.

We set up this particular system of standard weights with a definite purpose in mind. In the utility field

considerable experience had been gained as to the life of standard hot galvanized coatings—for example on strand,—in many locations and under many different conditions of exposure. On the principle that the life of zinc coating would be at least proportional to the weight of zinc coating, it would be easy for utility engineers to estimate the life expectancy of strand in either the "B" or "C" coating weights from previous experience with double galvanized strand under similar exposure conditions, and this new product enabled the utility engineers in many instances to increase the life of a given installation, located in regions of more severe service, without the necessity of going to more expensive strand materials.

These coating weights have become standardized by the American Society for Testing Materials in their specifications for galvanized steel wire strand, No. A122 and No. A218, from which the composite table of coating

weights has been prepared as shown in Table I.

THE ductility of the coating and the tight bond between the wire and the zinc makes it possible to use this wire in many woven products other than the conventional farm field fence. In chain link fence, for example, where heavy coatings were required to provide reasonable life in service, it had been the usual practice to galvanize the fabric after weaving. Such galvanized fabric usually carried a minimum average coating weight of 1.2 oz. of zinc per square foot of surface. Bethanized wire with either 1.2 oz. or 2.4 oz. minimum of zinc per square foot of surface is successfully woven into all of the conventional designs of chain link fence without injury to the zinc coating. A definite advantage possessed by this product is the uniformity with which the coating is distributed on the surface of the wire. Many types of conveyor belts and other woven products of loom and weaving machines are now available in either light or heavy zinc coating weights and fabricated directly from the zinc coated wire without difficulty.

Any number of chain products, such as pump chains, which heretofore have been galvanized after fabrication, can be formed directly from the zinc coated wire.

A large quantity of Bethanized wire in gauges of from 16 to 18 in "A", "B" and "C" coatings is supplied for drawing into very fine wire, such as wire used for screen cloth, and also for such purposes as air-cleaners, which are made from a flat rolled wire produced from round wire drawn down

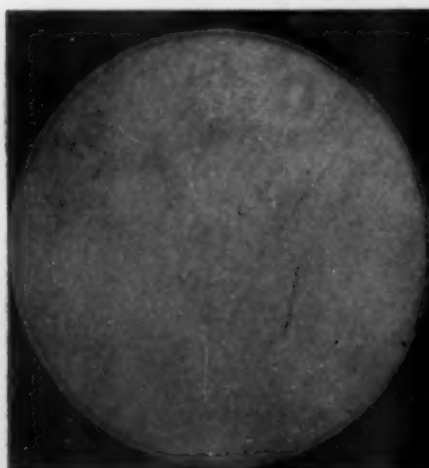


Figure 11. Unetched Section of Bethanized Wire. No. 12 gauge wire with 0.82 oz. coating weight. Magnification 25 diameters.

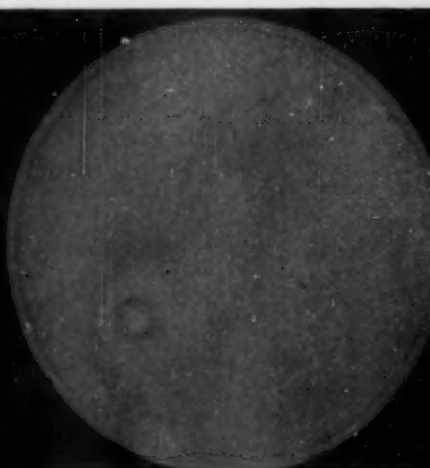


Figure 12. Unetched Section of Bethanized Wire. No. 12 gauge wire with 1.66 oz. coating weight. Magnification 25 diameters.



Figure 13. Unetched Section of Bethanized Wire. No. 12 gauge wire with 2.51 oz. coating weight. Magnification 25 diameters.

to diameters in the neighborhood of .006" to .009" and then fabricated on knitting machines.

As a matter of interest, I might state that the first problem that we tackled in connection with drawing Bethanized wire was in the production of some 3 mil filament wire. Our units could not possibly handle so small a gauge as .003" so we worked on the proposition of drawing that wire directly from a 16 gauge soft steel wire, carrying a coating weight of about 0.6 oz. of zinc per square foot of surface. This 16 gauge wire was successfully drawn through something like 49 dies to a diameter of .0033" without any loss of zinc coating or without any injury to the coating.

OUR next step in the development of the drawing of Bethanized wire was in the production of rope wire. We now use in substantial quantities, at our Williamsport Plant, Bethanized rope wire which is drawn to the finished size from stock which has been given the necessary thickness of zinc coating at its last patenting point. We have developed the wire drawing technique to the point that there is no difficulty in employing the percentage of total reduction observed in the manufacture of high quality bright rope wire. This practice involves a reduction from the last patenting point of from 70% reduction to 90%, or more depending upon the size of the wire and the particular type of rope into which the wire is to be fabricated. By this means it is obvious that we have a much wider range of physical characteristics available in rope wire than we previously had in the regular galvanized rope wire which we used prior to the development of this procedure. We can control the ductile properties of the wire so that the same or better torsional values are obtained as with standard high quality bright rope wire. Our range

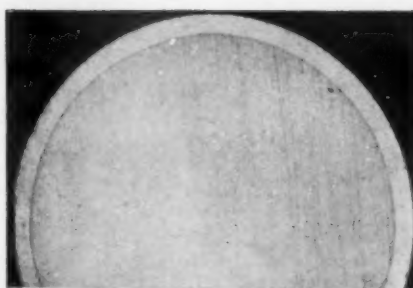


Figure 14. Unetched Section of Bethanized Wire. No. 9 gauge wire with 5.00 oz. coating weight. Magnification 25 diameters.

in tensile strength is materially extended, thus enabling us to produce ropes and hawsers of higher strength than formerly.

Furthermore, by means of the Bethanizing process we can provide heavier weights of coating than are ordinarily obtainable. An interesting example of such ropes is to be found in the construction of the world's largest pontoon bridge built at Lake Washington, Seattle, Washington. The cables used to anchor the pontoons of this bridge comprise about 25,000 feet of 2 3/4" diameter 6 x 35 rope with independent rope wire center. The individual wires making up this rope include a size range of from 0.106" to 0.141", all carrying a minimum coating weight of 1.6 oz. per square foot. The minimum specified breaking strength of these ropes was 620,000 pounds and the ropes showed an average breaking strength of 685,000 pounds. The operating rope for propelling the draw pontoon of this bridge was 1 1/2" diameter, of 6 x 25 construction with hemp center. The main wires of this rope were 0.095" diameter and the required coating weight was 1.4 oz. Incidentally, in the production of the wire for this rope, we patented the high carbon stock at 0.192" diameter, applied 3 oz. of zinc per square foot of surface to this patented stock and drew the wire to the finished size of 0.095",

which represents a little more than 76% reduction by cold work after galvanizing. The finished wire had an average tensile strength of approximately 240,000 pounds per square inch, and a coating weight of 1.5 oz. per square foot.

Many items of spring wire have been made by coating high carbon patented stock and then drawing it into the finished sizes.

To these examples may be added a great variety of manufacturers' wire items, which are used by companies who manufacture countless formed wire products. The coating weight on this wire often runs into the heavy coatings listed as "B" and "C". As a matter of information, Table II lists the manufacturers' standard coating weights for types 1, 2 and 3 galvanized wire and also shows our coating weights of "A", "B" and "C" for the representative sizes of manufacturers' wire.

In Figures 11, 12 and 13, are shown full cross section wire sections at 25 diameter magnification, made of 12 gauge wire coated with 0.8 oz., 1.66 oz. and 2.51 oz. coatings respectively. These illustrations are inserted to show the relative thickness of the standard coatings and they also make clear the degree of uniformity of those coatings. To compare with these, we have also prepared Figure 14, which represents a 5 oz. coating on a 9 gauge wire; as it was desirable to show this also at 25 diameter magnification, the limitation of the slide and negative dimensions prevented showing the full cross section.

Grateful acknowledgment is given to Dr. R. M. Wick, Mr. W. C. Clements and the Metallurgical and Operating Departments of the Johnstown and Sparrows Point Plants of the Bethlehem Steel Company for valuable help and advice in the preparation of this paper.

Electrodeposition of Silver

(Continued from page 75)

ings and also the anode efficiency. When these substances were present, anode coatings still appeared but it was no longer in a hard form that restricted the flow of current, but rather it was in a loose form.

IN MOST cases, the anode efficiency was from 70 to 80%. The cathode efficiency was 100% and because of the lower anode efficiency, a gradual depletion in metal occurs in the solution so that it is not suitable for continuous electrolysis.

A regeneration by the addition of silver is not successful because during the dissolving of the silver, 20 to 30% of the anode work goes to the production of undesired side reaction products which accumulate and gradually harm the bright plating effect. An example of bath composition is as follows:

Silver as AgCl	40 g./l.
Sodium thiosulphate, Na ₂ S ₂ O ₃ · 5H ₂ O	170 "
Sodium bisulphite, NaHSO ₃	20 "
Sodium sulphate, Na ₂ SO ₄	50 "

(Concluded on page 87)

Magnesium Alloy Processing[†]

BY JAMES P. ApROBERTS

Technical Dept., Turco Products, Inc.,
Los Angeles, Cal.

This is a welcome addition to the scant published literature on processing of magnesium alloys. The equipment needed, precleaning, alkaline cleaning and rinsing before treatment are described. Treatment processes discussed include: Dow Treatment No. 1 or "Chrome Pickling", dichromate treatment and anodizing.—Ed.

Introduction

MAGNESIUM itself is a silvery-white metal vital to national defense because of its lightness and strength. The amount of magnesium in an average attack bomber, engine included, has been estimated to be 800 pounds of magnesium alloys.¹ This figure will undoubtedly be increased as more magnesium becomes available. New or improved methods of refining and extraction are developing the production of this metal to a point where it will compete with many other metals on a cost per unit of area basis. The experience gained in treating it for defense purposes will also be of value in peacetime processing.

There are many methods of treating or processing magnesium. The predominant purpose of a majority of these is protective. This paper, however, will be confined to the treatments which are most commonly used and specified. Platers will be interested in knowing that only one of these is electrochemical. However, that fact should not reduce their interest in this subject because of the following reasons.

Equipment

Much of the average plating shop's equipment can be used, such as hot and cold tanks, rinse tanks, racks and ventilating devices. The chemicals required are, in most instances, not hard to get and furthermore, if the plater is doing defense work, they can probably be purchased on a basis of priority. The only other equipment which might be required would be devices for recording and controlling temperature and current consumption.

Furthermore, electroplaters have skill and experience in cleaning, racking, solution control and analysis, familiarity in handling many of the chemicals used in magnesium treatment, plus an especial ability to produce uniform finishes. These facts should be considered in any allotment of this work. There are, however, certain differences between processing magnesium and other metals.

Cleaning

The first and most important of these is cleaning.² If



James P. ApRoberts

magnesium parts are not well cleaned, the effectiveness of subsequent treatments is reduced and rejects because of paint failure, pitting and corrosion are likely to follow. All of the processing methods which will be discussed rely upon cleaning with the correct materials according to a schedule similar to the following:

I. Precleaning

Degreasing by either

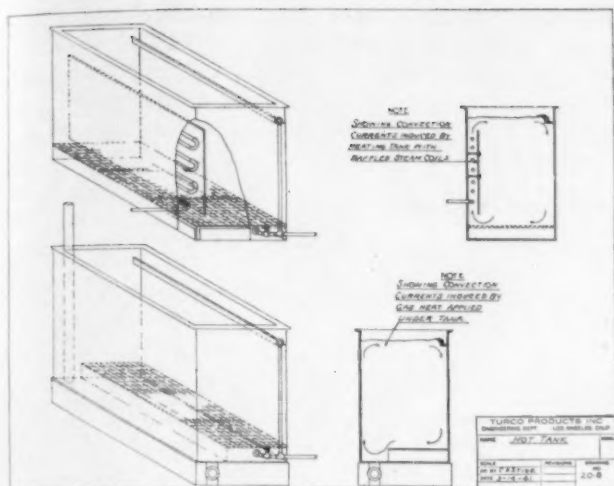
1. Solvent (vapor degreasing).
2. Emulsion or "hot tank" method.
 - (a) Using special materials such as emulsifiable solvents.
 - (b) Thorough cold water spray rinse.

[Note: If parts received are free from mold lubricants and other oils, or have been "chrome-pickled," step I can be omitted.]

II. Cleaning

1. Immersion in a hot tank solution.
 - (a) Cathodic electrocleaning with special alkaline cleaner.
 - (b) Boiling for a longer period in alkaline cleaner.
2. Hot water rinse.
3. Cold water rinse.

[†] Presented to the Nov. 12, 1941 meeting of the Los Angeles Branch, American Electroplaters' Society.



Drawing illustrating tanks for precleaning.

Note: Any obdurate films not removed by the above should be treated with either:

1. A hot chromic acid solution
 - (a) Cold and hot rinse.
2. Concentrated nitric, sulfuric acid solution
 - (a) Cold and hot rinse.

PRECLEANING

Precleaning by degreasing is often required because of the common use of cocoa butter³ and similar materials as mold lubricants for castings. Their high melting point and affinity for magnesium surfaces makes removal a difficult problem. The best answer appears to be found in degreasing. Removal of such impregnated oils and all other contamination by a single cleaning operation requires excessive time and does not produce the clean surface that is required for subsequent treatments.

SOLVENT DEGREASING

Precleaning methods available to platers are solvent, better known as "vapor" degreasing, and hot tank or emulsion precleaning. The type of unit to use depends upon the shape and thickness of parts to be cleaned. For instance, small parts can be handled by a small degreaser, since the cleaning time is quite short. Users of large or assorted parts often find it convenient to use larger or even conveyerized units.⁴

In general, the same solvent degreasing equipment now used by platers for precleaning other metals can be used for magnesium. However, care must be taken to see that the degreasing solvent is kept as clean as possible and large quantities of oil and dirt are not allowed to accumulate in the machine.

EMULSION PRECLEANERS

A successful alternate method is to use an emulsion precleaner or an emulsifying solvent cleaner. Immersion time depends upon the contamination of the work and cleaning solution. Five minutes is the average length with the above materials. The hot tanks to be used are the same type which the plater may already have lying idle or they

can be readily built or devised as shown by the accompanying illustration.⁵

Whenever badly soiled parts are encountered, precleaning should be considered. It will accelerate the cleaning cycle and prolong the life of the prime cleaning solution. However, no magnesium cleaning cycle is complete without boiling or cathodically electrocleaning the work in a specially devised alkaline cleaner.⁶ This is done in order to remove all traces of grease, oil and previous treatments.

Immersion time, of course, depends upon the original cleanliness of the part. A good general rule for acceptable cleanness is that the work is clean when, after ten minutes of boiling, no surface contamination is visible and no water-breaks appear.

ELECTROCLEANING

Cathodic electrocleaning⁷ offers the advantages of greater solution agitation with a "bubble curtain", and more rapid cleaning action. A direct current of 10 to 30 amperes per square surface foot with solution conductivity increased by using a more concentrated solution (6 to 12 ounces of cleaner, for example) are common operating conditions. Shorter electrode distance and higher operating temperatures will also increase both conductivity and cleaning efficiency. This method requires about one-third the time of ordinary cleaning, and parts racked and cleaned may be kept racked for the remaining operations.

Some operators are finding conductivity measuring devices, such as the "Solu-Bridge", to be convenient means of controlling the efficiency of electrolytic cleaning solutions.

Rinsing Before Treatment

Following either operation, the work should first be thoroughly rinsed in fresh hot (180° F.) water and then given a cooling down rinse in cold water in order to eliminate the tendency for carried over solids to dry on and cause a "whiskered" appearance.

Note: Occasionally certain alloys will retain a very stubborn gray-colored oxide film which will seem to resist even the above-mentioned alkaline cleaning operation. Because it will interfere with the effectiveness of subsequent processing on such parts, one of the following methods should be employed.

The first² is a ten-second dip in a solution of 8 parts by volume of concentrated nitric acid, 2 parts concentrated sulfuric acid and 90 parts by volume of water. This method will remove some of the base metal and where tolerances should be held, the following nonattacking treatment⁸ is recommended: The work is immersed for from one to five minutes in a solution of chromic acid (24 oz./gal.). The water used in preparing this solution should be low in chloride content. In both instances, these operations are followed by a thorough cold and then hot water rinsing.

A third and often most convenient method² is to simply rub out the oxide by sanding. This is particularly recommended for thin sections or sheet stock. Wiping and then rinsing will complete the operation.

In discussing magnesium cleaning, it is well to bear in mind that it is unlike cleaning aluminum⁹. Both metals may be light and silvery, but what is often good practice for one may either be ineffective or else too drastic for the other. Aluminum cleaners are often mildly alkaline, where-

as strongly alkaline cleaners are safer on magnesium. The nitric acid dip, which was limited to ten seconds for magnesium, would actually passivate an aluminum surface.

The last named chemical treatment mentioned chromic acid. Platers will be interested to know that technical grades of all of the chemicals mentioned in this article may be used provided that due allowance is made for the lower percentage of active ingredients and the content of salts of the heavy metals kept at a minimum.²

Actual Treatments

The remaining operations differ according to the type of treatment which is to be applied. This in turn depends upon the decorative or protective requirements of the consumer. At present only protective treatments are being specified.¹⁰ These secure greater protection for the work by developing a passive corrosion-resistant film. Paint adherence and durability is improved because of the pebbly nature of these films which afford the paint a better grip. Rupturing and failure by the formation of a destructive undercoat of magnesium hydroxide is also retarded since the film acts as a protective undercoat for the paint and also retards destructive corrosive action.¹¹

This paper will be limited to a description of the four most commonly specified protective treatments. A more detailed description of each of these will probably be of greater value to the plater than attempting to cover the entire field which seems to be in a very developmental state.

"CHROME-PICKLING"

The first treatment, Dow #1 or "chrome-pickling",^{9, 12, 13} passivates and slightly etches the metal's surface in order to give it good protection during the processing period between manufacturer and fabricator (in defense terminology this would be between contractor and subcontractor). Because of its etching action, from 0.0006 to 0.002" of surface (or twice that for diameter) is removed and hence it is not recommended as a final treatment or to be used on parts with close tolerances. It is a treatment which can be applied to parts containing brass or steel inserts if those inserts are thoroughly masked off. As already mentioned in an earlier paper on pickling,¹⁴ this is a simple dip operation performed as follows:

After cleaning the parts as described above, dip the work for one-half to two minutes in a bath containing 1½ pounds of sodium dichromate, 1½ pints of concentrated nitric acid (sp. gr. 1.42) plus water to make a gallon of solution. Operation time depends upon the freshness of the solution, which is estimated by the matte color of the finish. When parts are removed they should be suspended above the bath for about five seconds and allowed to drain. During draining, the color will improve to the final result. Nitric acid and sodium dichromate should be gradually added to keep the coating at a matte or semi-matte gray to yellow-red coloring. The best chemical control of the bath is obtained by analysis according to methods obtained from the Dow Chemical Company of Midland, Michigan. Final operation is rinse in cold running water followed by a dip in hot water to facilitate drying. Aluminum, stainless steel or ceramic tanks may be used for containing the solution.

"SEALED CHROME-PICKLE"

An additional step which improves the corrosion resist-

ance of "chrome-pickling" is known as the "sealed chrome-pickle."¹⁵ Parts, especially die castings, which have already been "chrome-pickled" are boiled for thirty minutes in a solution of between one and two pounds (enough to maintain a pH of 4.0 to 4.4) of sodium, potassium or ammonium dichromate per gallon of water.

FINISHING TREATMENTS

The three remaining treatments, shown on the accompanying chart below:

List of Specifications Applicable to the Same Treatment

Common Name	Dow Chemical Company Number	Navy Aeronautical	Army Specification
"Chrome-Pickle"	1	M-303a	98-20010-A par. E-3A
"Acid-Dichromate"	7	Alternate for PT-13	98-20010-A par. E-3B
"Alkaline-Dichromate"	8	M-382 or Alternate for PT-13	Alternate for No. 7
"Anodizing"	"13"	PT-13	No Equivalent

are more complex. They require from two to four operations after cleaning. However they do not affect the dimensions and are commonly used as final treatments. Of the three, Dow #7 or the acid dichromate is possibly the most popular. They all produce superior corrosion-resistant films and give good paint base coatings.¹⁶

ACID AND ALKALINE DICHROMATE TREATMENTS COMPARED

The acid and alkaline dichromate treatments differ only in the last two treatments. Steel or brass, but not cadmium plated, aluminum or other metal inserts are unaffected by these two treatments. The initial operation following cleaning as previously described is a five minute immersion in a water solution containing 15% to 20% by weight of hydrofluoric acid (HF) at room temperature. This can satisfactorily be prepared by diluting one volume of 48-52% technical HF with two volumes of water. While the solution is very slowly depleted, it should not be allowed to go below 10% as shown in a free acid titration against normal NaOH with phenolphthalein as an indicator. A 2 cc. sample should require between 10 and 20 cc. of N NaOH.

Following a very thorough rinse in cold running water to prevent any acid carryover, the parts are next boiled for at least 45 minutes in a 10% sodium dichromate solution (this corresponds to ¾ pound of technical sodium dichromate per gallon). The original solution level shall be maintained by adding water to replace that lost by evaporation. Rinse parts thoroughly in cold running water and follow by a dip in hot water to expedite drying. A five minute dip in tung oil at 302° F. is sometimes used as a sealing coat.^{16, 17}

ALKALINE DICHROMATE

Dow treatment #8,^{2, 18} or the alkaline dichromate process, differs from the acid dichromate in that it has two different steps following the hydrofluoric acid immersion. The first consists of boiling for at least 45 minutes in a water solution of the following (see note on technical grades, if they are to be used): Ammonium sulphate, 3% (4 oz./gal.); sodium dichromate, 3% (4 oz./gal.) and ammonia (sp. gr. 0.880), 0.25% (1/3 fl. oz./gal.). The original level is maintained by additions of water to replace that lost by water.

Following a thorough rinse in cold running water, the work is then placed for 5 min. in a water solution containing 1% by weight of arsenious oxide which is the equivalent of $1\frac{1}{3}$ ounces per gallon of technical arsenious oxide. It is better to maintain the original solution level with additions of water to compensate for evaporation losses and replace once a month rather than attempt to control this solution, because of its very low cost. Again rinse parts in cold running water and then give them a drying dip in hot water.

FURTHER COMPARISON BETWEEN ACID AND ALKALINE DICHROMATE SOLUTIONS

It might be well to note that the acid dichromate solution will treat approximately twenty full tank loads as against ten for the alkaline dichromate. The pH is the best type of control for either solution. The pH of the acid dichromate solution is kept between 4.5 and 5.5 by additions of 10% chromic acid solution. On the other hand the "alkaline dichromate" bath should be maintained at between pH 5.6 and 6.2 by additions of a solution containing 5% by weight each of chromic and concentrated sulfuric acids. Iron, aluminum or other commonly used tank materials are acceptable for all of these solutions except the hydrofluoric acid, which requires a wooden or lead-lined tank.

Anodizing Magnesium

The fourth method to be considered is anodizing. It is covered by Navy Aeronautical¹⁷ Specification PT-13. In this instance, parts must be electrocleaned cathodically, as mentioned above, for three minutes at 194° F. or above. The voltage must be high enough to give a vigorous evolution of gas. Rinse thoroughly in clean warm water.

Following this first electrocleaning operation, the parts are immersed in a solution of sulphuric acid, one-half gallon of acid per 100 gallons of water. They should be scrubbed with pumice if necessary and rinsed thoroughly in clean warm water. Then the electrocleaning should be repeated followed by a warm and then a cold water rinse. Now they are ready to be "anodized". This is unlike anodizing aluminum, for a bath containing a solution of 10.8 oz./gal. of chromic acid, 4.1 oz./gal. of phosphoric acid, and 7.5 oz./gal. of 29% ammonium hydroxide is used as the electrolyte at 122° F. The work is treated anodically for thirty minutes at a current density of 5 to 10 amperes per square foot and at potential of 3-6 volts. Then the parts are rinsed thoroughly in clean warm water and given a drying dip in hot water.

After the parts are dried, the specification states that they shall be immersed in tung oil kept at $302^{\circ}\pm 4^{\circ}$ F. until the evolution of gas escaping from pores in the metal has ceased. This requires approximately five minutes. They are then removed from the oil and dried either in air or an oven.

The anodic bath is maintained at a pH of between 4.2 and 4.8 by the addition of a stock solution containing chromic acid, 40 ounces per gallon, and 55% phosphoric acid, 16 ounces per gallon.

Conclusion

From these remarks it should be apparent that platers can do magnesium processing. There are many other types of magnesium processing which could have been discussed but which were omitted because they were not entirely pertinent to this subject. It is hoped that this paper will

serve as a suggestion and show metal finishers a means whereby they can possibly participate in national defense projects without having to entirely remodel their shops. With the data included in this paper, much of which was furnished by the Technical Department of Turco Products, Inc., under the direction of S. G. Thornbury and E. R. Holman, electroplaters should be able to see how and where they can fit into the magnesium-finishing picture.

Bibliography

1. Editorial, Chemical and Metallurgical Engineering, September, 1941; page 84-10.
2. Dow Chemical Company Bulletin No. DM-17; Dow Chemical Company, Midland, Michigan.
3. Turco Products, Inc., Bulletin A-652, "Surface Treatment of Magnesium Castings"; Turco Products, Inc., 6135 South Central Avenue, Los Angeles, Calif.
4. O. B. Moe, Sales Engineer, G. S. Blakeslee & Company; private comment.
5. Taken from Turco Products, Inc., Bulletin A-533-B, "A Quick Glance at Cadmium Plating"; Turco Products, Inc.
6. H. W. Schmidt; recent report before the A.S.T.M.
7. Turco Products, Inc., Bulletin A-533-B, pages 4 to 8; Turco Products, Inc.
8. Editorial, Chemical & Metallurgical Engineering, September, 1941, page 288.
9. John A. Gann, "Protection of Magnesium Against Corrosion", page 1612, Metals Handbook (1939 Ed., published by American Society for Metals).
10. S. H. Phillips, "Aircraft Processes", page 38, (1941 Ed.); published by The Crocker Company, Los Angeles, Calif.
11. McKay & Worthington, "Corrosion Resistance of Metals and Alloys", page 109, (1936 Ed.), published by Reinhold Publishing Corp., New York, New York.
12. U. S. Navy Aeronautical Specification M-303a, dated May 1, 1939.
13. U. S. Army Specification 98-20010-A, par. E-3A.
14. J. P. ApRoberts, "Still Tank Pickling"; The Iron Age, May 29, 1941.
15. J. P. ApRoberts, "This Corrosion Bug"; Aero Digest, June, 1941.
16. U. S. Army Specification 98-20010-A, par. E-3B.
17. U. S. Navy Aeronautical Specification PT-13, dated August 13, 1941.
18. U. S. Navy Aeronautical Specification M-382.

Electrodeposition of Silver

(Continued from page 83)

In place of the sodium sulphate, sodium chloride, acetate or citrate can be used. The most favorable current density is between 0.3 and 0.5 amp./dm². (3 to 4.7 amp./ft²). If one is merely seeking the production of brilliant silver coatings, perhaps the use of a simple solution of silver chloride dissolved in thiosulphate without the additions, would be the most favorable.

The brightness of the coatings is considerably affected by the current density. Freshly prepared solutions frequently require a short electrolysis before they produce bright coatings, and in spite of this, uncertainties still remain. No changes in the working conditions or reactions of the bath can be observed when agitating the solution, but a greater certainty is obtained by agitation, in producing the desired expansion of the bright plating range.

References

1. R. Weiner, Zeitschrift für Elektrochemie, **45**, 743 (1939).
2. M. Schlötter, J. Korpion and Burmeister, Zeitschrift für Metallkunde, **25**, 107 (1933).
3. H. Gockel, Zeitschrift für Elektrochemie, **40**, 302 (1934).
4. M. Schlötter, German Patent No. 608,268.
5. Kodak Pathe, French Patent No. 704,663.

Recovering Cadmium from Racks

Q. How can we recover cadmium from plating racks which have become heavily coated with the metal? We wish to obtain the cadmium in a form so it can be used again in the plating solution.

A. If the racks are made of brass, it is not readily possible to remove the cadmium chemically so that it may be used in the plating solution. The deposit can be chipped off and the chips placed in an anode basket made of something like expanded metal. The basket can be lined with a small iron mesh to prevent the chips from falling out.

A better procedure would be to use racks made of steel. Then when the rack has become coated it can be hung on the anode rod of the plating tank. This requires that a few extra racks over that required for production be made.

Defective Silver Strike Solution

Q. We are sending you, under separate cover a sample of our strike solution and also two sample pieces of forks, one of which is from the strike without any further plating, and the other with the full deposit which we put on our silver plate.

You will notice that on the plated sample the surface is very streaky and is very difficult to cut down without cutting off a lot of the silver plating.

We have had similar trouble in the past and usually found that it was associated with our strike, because immediately on making a new strike the trouble stopped.

We would appreciate it if you would examine these samples and our sample of strike solution, and tell us if the strike is the cause, and if so what type of contamination is getting in the solution.

A. Your solution showed the following:
Silver 0.21 tr. oz./gal.
Free sodium cyanide... 9.7 av. oz./gal.

An examination of the forks sent with the sample of solution shows that the deposit is granular, and would be difficult to color up, as you state. Several causes for such trouble may be found. It is suggested you examine the following:

Coarse crystal structure of the base metal due to incorrect annealing.

Strapping operation, in polishing between the times, is causing overheating and oxidation of the metal which is not completely removed by acid pickling before plating.

The strike solution builds up in carbonates. The analysis of your solution as given above shows the free cyanide to be all right, but the silver is slightly low. Up to $\frac{1}{2}$ oz./gal. of silver is generally run. High carbonate content will cause granular deposits. It is

Technical Advisors For February Issue

H. LEROY BEAVER,

Barrel Finishing
Consultant
Lansdale, Pa.

G. B. HOGABOOM, JR.,

Consultant in Electro-
plating, and Metal
Finishing
Newark, N. J.

suggested you follow the carbonate formation in the strike as it is operated.

When the carbonate has built up in the strike to a point where it is affecting the character of the deposit, the old strike can be set one side for recovering of the silver, or, if metallic impurities in it have not built up, the old strike can be put in to the plating solution. Then a portion of the plating solution is taken of sufficient quantity so that when diluted to fill the strike tank, sufficient silver will be present in the strike. Then add cyanide required. This practice will add carbonate to the plating solution, but is not serious if as is the case in many plants, the drag out of the solution is sufficient to hold the carbonate below 6 or 8 oz./gal.—G.B.H., Jr.

Burnishing Balls for Jewelry

Q. Could you tell me if these burnishing balls are in good enough condition to be used in barrel burnishing jewelry. Also if they are the right size and shape to use. What is the best type of burnishing soap to use?

A. The sample of steel burnishing material submitted consists of about equal parts of $\frac{3}{16}$ " round balls and $\frac{3}{16}$ " diagonal polishing steels. This material has rusted at some time, and apparently some effort has been made to relieve this condition by either acid dipping or in lieu of that, some form of abrasive treatment. Under simple magnification, and this is the best test, the surfaces appear badly pitted and the material is altogether unfit for barrel burnishing either jewelry or any other product where bright finish is sought. The sharp edges left from the rust pits would defeat any satisfactory burnishing result and provide only a matte finish caused by abrasion.

Whether material of this size is satisfactory depends solely on the type of parts

to be burnished. Burnishing materials must always be selected with respect to the form and size of the parts to be finished, and we prefer to use the smaller sized units for jewelry due to their ability to reach into, and finish grooves and angles that would not be reached by the larger sizes of materials. As a general rule, we believe it would be found that a mixture composed of equal parts of $\frac{1}{8}$ " diagonal steels and $\frac{1}{8}$ " o.d. cones is best for the widest range of jewelry applications. It is doubtful whether this may now be secured except under priority and for defense production.

There is no "best" barrel burnishing soap. Generally speaking, a tallow base soap provides the best lubrication which is essential in barrel finishing practice. Such a soap should always be used with suitable alkaline builders. The soap content should be not less than 60% of at least 88% real soap of average titer of about 42. The 40% of alkaline builder must be composed of such materials that will reduce the water hardness to zero and that will prevent the formation of insoluble lime soap films, and burnishing soaps should be quite heavily silicated to provide for more complete and easy rinsing. The addition of "wetting agents" is, of course, optional and depends upon conditions in the locality where the soap is to be used. No formula could be suggested in the absence of knowledge of water conditions.—H. L. B.

Copper Plate for Selective Hardening

Q. What thickness of copper plate is usually used as a stop-off for selective hardening?

A. As a stop-off in selective carburizing, copper plate from a cyanide copper solution is usually used. Inasmuch as carburizing involves diffusion of gases, it would be expected that the degree of protection afforded by any thickness of copper plate would be influenced by the structure of the plate e.g. grain size, orientation and porosity. The best method of determining the required thickness is by empirical means. A 0.0003" plate may be satisfactory for short treatments and a 0.002" coating may be required for long carburizing treatments. In liquid carburizing, the copper plate dissolves slowly in the carburizing medium. Cleaning of the surface prior to plating should be done as carefully as in normal plating and many cases of hardening through copper plate have been as a result of improper surface preparation prior to copper plating.—W.R.M.

Patents

Chromium Plating

U. S. Pat. 2,248,530. E. R. Granger & R. Ellesworth, July 8, 1941. An article having an antifriction surface which is of chromium, said surface being covered with a multiplicity of indentations of the character produced by blasting a metal surface with an abrasive having a size ranging from about 4 mesh to 150 mesh followed by chromium plating to a thickness of about 0.001" to 0.01", said surface being free from burrs, in combination with a second article whose surface is in relative motion and the contact pressure is below that causing deformation of the second surface to such an extent that said second surface is caused to enter said indentations thereby increasing the friction therebetween. The indentations have diameters ranging from about 0.004"-0.185" and depths about half the diameters. They may be filled with lubricant.

Automatic Plating Machine

U. S. Pat. 2,256,560. A. H. Hannon, Sept. 23, 1941. An automatic plating conveyor of novel design.

Anode Salvaging

U. S. Pat. 2,256,820. G. W. Veale, assignor to Eaton Mfg. Co., Sept. 23, 1941. An anode structure comprising an elongated metal member encased in a protective metal covering and having horizontal threaded pins along its length into which anode stubs are screwed. The pins are made of the same material as the anode stubs so that substantially the whole stub is used up.

Protective Coating

U. S. Pat. 2,255,979. H. L. Kohler, assignor to A. A. Kramer, Sept. 16, 1941. The method of making a corrosion resisting coating having the appearance of a galvanized coating on a galvanized metallic sheet, comprising making a soft, creamy, putty-like amalgam principally of mercury, lead and tin, containing from 50% to 80% mercury by weight, from 16.67% to 6.67% lead by weight, and from 33.33% to 13.33% tin by weight, applying a thin coating of said amalgam to said sheet, removing excess amalgam from said sheet, and leaving said coating undisturbed until said amalgam penetrates and amalgamates with all the zinc on the area of said sheet having said amalgam applied thereto and said coating hardens after such complete amalgamation.

Buffing Wheel

U. S. Pat. 2,263,410. W. S. Thomas, Nov. 18, 1941. In a buffing wheel section, a plurality of helically wound buffing fabrics, a plurality of helically formed members for supporting same, a central hub and means for connection, whereby an air space is provided between the fabric and the inner periphery of said hub.

Electroforming

U. S. Pat. 2,258,579. A. C. Dunn, Oct. 7, 1941. The method of making molds comprising placing a plurality of molds on a plate, pouring plastic material over said molds to bind them together, removing the plate, electroplating the surface of said molds and said material to form a single electroplate, reinforcing said electroplate with plaster, and removing the plastic material.

Blasting Machine

U. S. Pat. 2,258,634. D. C. Turnbull, assignor to The American Foundry Equipment Co., Oct. 14, 1941. A machine for centrifugal abrasive blasting, including a conveyor advancing means.

Plating Rack

U. S. Pat. 2,258,391. J. Novitsky, Oct. 7, 1941. A plating rack with prong contacts of wire which are woven in between sections of the vertical spine, this being the only fastening.

Metal Spray Gun

U. S. Pat. 2,268,202. W. M. Britton, Dec. 30, 1941. A metal spray gun having a wire feeding device of novel design.

Abrasive Blasting Machine

U. S. Pat. 2,264,265. E. R. Hughes, assignor to The American Foundry Equipment Co., Nov. 25, 1941. A centrifugal type of abrasive throwing machine of novel design.

The FINISH that will add
instant sales appeal
to *your* product.

EBONOL
REG. UNITED STATES PATENT OFFICE

THE JET BLACK CORROSION RESISTANT
FINISH FOR IRON AND STEEL

Leading manufacturers of appliances, bicycles, coffee makers, radios, guns, bearings, buckles, buttons, tools and hardware, are using EBONOL to beautify their products and replace zinc, cadmium, nickel and other finishes.
Plants now doing plating need only ONE new tank to start using EBONOL.

Some proven advantages of EBONOL:
Fast Blackening by Immersion
in Only ONE Bath
Deep Penetration—No Red Stains
Highest Corrosion Resistance
Simple and Economical to Operate

Send sample parts to be EBON-ized
and let our finishing engineers serve you.

THE **Enthone** COMPANY
NEW HAVEN CONNECTICUT

NEW EQUIPMENT AND SUPPLIES

NEW PROCESSES, MATERIALS AND EQUIPMENT FOR THE METAL INDUSTRY

Motor Driven Oblique Plating Barrel

A new and improved oblique plating barrel drive has been developed by the Hanson-Van Winkle-Munning Company, Matawan, N. J. This Type 34 oblique barrel is now available in a new model, directly driven by a 1/6 HP motorized worm gear reducer which is suitably mounted on the tank, ready for connection to the user's power lines. The arrangement readily permits the removal of the cylinder for rinsing, loading and unloading of the work.



Motor driven oblique plating barrel.

This barrel can be furnished with a wooden tank, asphalt lined; or a steel tank, unlined or lined with 3/16" vulcanized rubber. The cylinder is all of bakelite construction with disc or button type contacts; or of hard rubber with disc type contact only. The panels in the bakelite cylinder are 1/8" thick; in the hard rubber cylinder, 1/4" thick. This unit will handle about 25 lbs. of work per batch.

The same type of drive may be applied to other units made by the company, in sizes down to 10 lbs. of work per batch.

Plastic Gloves to Withstand Chemicals

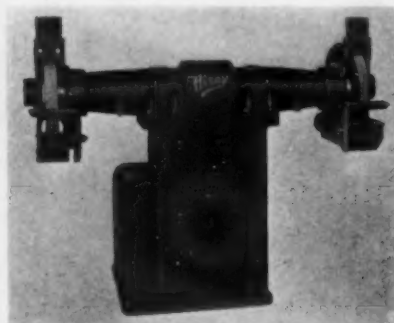
The Surety Rubber Co., Carrollton, Ohio, have just introduced a new line of industrial gloves called "Suresal," made from a new synthetic plastic material, which is stated has sufficient elasticity to give ample flexibility and comfortable finger freedom. These gloves are recommended to protect the hands from caustics, acids, solvents, oils, etc. The transparent plastic is also applied as a bonded coating to various styles of fabric and leather work gloves of the company's line, and is also available in aprons and fingercoats.

The material is stated to be inert, non-toxic, odorless and tasteless. It is also said to be resistant to sunlight or to violet light, acids, alkalies, alcohols, ketones,

esters, aromatic hydrocarbons, aliphatic hydrocarbons and mineral, animal and vegetable oils that usually attack and destroy natural rubber, and other substitute materials. Resistance to abrasion and tearing is also claimed to be particularly good.

Wide Swing Grinder

Illustrated herewith is a new type "FE Wide Swing Grinder" of the Hisey-Wolf Machine Co., Cincinnati, Ohio. The outstanding advantages of this grinder is the large space between wheels and the almost unlimited working clearance around the wheels, which permits the grinding of large awkward pieces and of irregularly shaped work. The motor is mounted on the rear of the pedestal and a V-belt drive operates the spindle.



Wide swing grinder.

The machine can be furnished without the guards for buffing and polishing operations. The grinders are available in three sizes using respectively 2, 3 and 5 HP motors.

Literature is available describing the grinders and giving specifications.

New Belt Grinder

As a new addition to their line of Wet and Dry Abrasive Belt Grinders, the Porter-Cable Machine Company of Syracuse, New York announces a small abrasive belt sander-grinder using a belt four inches wide by forty-five inches in circumference. This grinder is so equipped that it may be used either with dry belts or with the new type, resin bonded abrasive belts on which water or other coolant is sprayed. A three-quarter horse power, 1725 R.P.M. ball bearing, totally enclosed motor, directly connected to the drive pulley of grinder, gives a belt speed of 3400 surface feet per minute, travelling over a flat backing



Belt grinder in horizontal and vertical positions.

plate four inches wide by ten inches long, allowing a working surface of forty square inches. Two convenient hand adjustments

Professional Directory

G. B. HOGABOOM JR. & CO.

Consulting Chemical Engineers

SALT SPRAY TESTING — CERTIFIED TO MEET ARMY AND NAVY SPECIFICATIONS. Testing of deposits—thickness, composition, porosity. Solution analyses, plant design, process development.

352 Mulberry St. Newark, N. J.

Platers Technical Service Co.

Electroplating and Chemical Engineers

Complete services, including solution analyses, process development and deposit tests. S. C. Taormina Tech. Director
Dr. C. B. F. Young Tech. Advisor
Dr. G. Amorosi Engr. Advisor
(Professional Engineer)

59 E. 4th St., N. Y. C. ORchard 4-1778

Joseph B. Kushner, Ch.E.

Metal Finishing Consultants

Plating plants streamlined for defense work.

233 W. 26th St., N. Y. C.

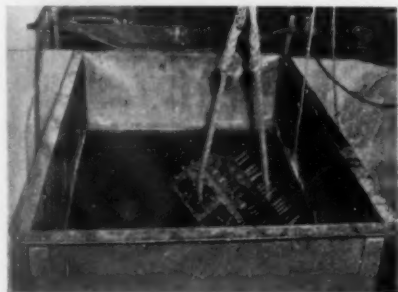
simplify the application, removal and alignment of abrasive belts. A removable side guard exposes the entire interior. The cast iron pedestal on which the complete unit is mounted is substantial yet light enough to make the machine readily portable. A position change from vertical to horizontal, or even horizontal with the belt underneath can be quickly made by removing three bolts. The slotted rest table is adjustable up to a forty-five degree angle.

The Type G-4 is recommended for sanding or grinding small parts composed of wood, metals, plastics, glass, fibre, hard rubber, ceramics and other materials where a clean, uniform surface is desired, pieces to be squared or radii to be generated. It will also handle many light milling and grinding operations without the use of fixtures, thus saving lock up and tool travel time over voids in scattered areas.

Degreasing Solvent

Curran Corp., Malden, Mass., have announced a material called Gunk X-11, to remove grease, oil and solid dirt from metal preparatory to finishing operations.

It is recommended as a substitute for trichlorethylene vapor cleaning and is particularly recommended where heavy duty cleaning is required. The cleaning method involves immersion of the greasy parts in a cold solution of the company's material diluted with such solvents as kerosene.



Engine part being immersed in cold emulsion cleaner.

After swishing the work in such solution, it is removed and the oil and cleaning compounds sluiced off with water spray.

Only a minimum amount of equipment is required inasmuch as no heat is necessary and long-life and low cost are claimed for this cold emulsion tank method of metal cleaning.

Engineering data sheets are available from the company on request.

Metal Pickling Concentrations Electrically Checked

Industrial Instruments, Inc., 156 Culver Ave., Jersey City, N. J., have devised a method of checking pickling bath concentrations and similar solutions by means of the solu-bridge, which is a rugged, shop-type Wheatstone bridge utilizing the "magic eye" as the indicator of balance



Electrical control for checking concentration of pickling baths.

which serves to measure the electrical conductivity of the solution in the desired terms. The instrument enables the determining of the concentration of sulphuric acid pickling solutions that have been contaminated with copper sulphate, and the operations are stated to be easily performed by the average plant worker.

The readings are obtained directly by turning a knob until the "magic eye" indicates balance. The instrument can be operated, it is said, by any plant worker, with speed and accuracy. In the case of pickling solutions, the readings are obtained in terms of sulphuric acid concentration. It is calibrated for 0-10% as H_2SO_4 with the scale arranged for easy reading in the range about 5%. Other ranges of calibration in terms of different percentages of sulphuric acid, sodium hydroxide or reciprocal ohms $\times 10^{-6}$ are available on order.

Hammond "OD" POLISHER
($\frac{1}{4}$ " to 9" Diameter)

HI-SPEED PRODUCTION

THRU
VARI-MATIC
CONTROL

HIGH SPEED!
FAST FEED!
LOW COST!

WRITE FOR
BULLETIN GP-11

The Hammond OD Polisher has capacity for finishing $\frac{1}{4}$ " to 9" diameter cylindrical pieces (larger if desired). It is a sturdy, substantial, low-cost operating machine using for the polishing member various types of wheels on abrasive belts required

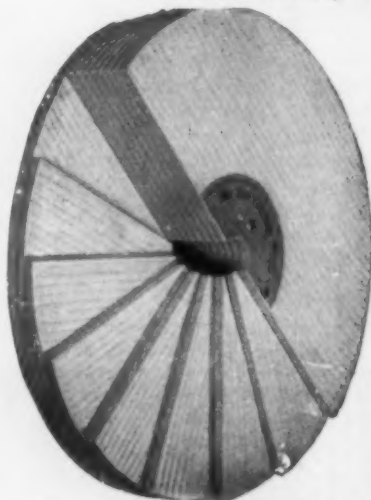
to finish the work. Special fixtures allow wider range of use. Fully enclosed . . . visible indicators and easily accessible controls permit inexperienced operators to secure desired finishes at high production rates. Write for Bulletin GP-11.

Hammond Machinery Builders
INC.
1801 BOUGLAS AVENUE • KALAMAZOO • MICHIGAN
EASTERN BRANCH • 71 WEST 23RD STREET, NEW YORK CITY

★ STAR ★

PEERLESS POLISHING WHEELS

For Every Requirement



Parasewed Bleached Muslin Wheel



Black Star Quilted Sheepskin Wheel

- ★ Para-Sewed Muslin Wheels are constructed specifically for every use and are unexcelled for durability.
- ★ Special Construction insures a uniform density throughout and is truly a wheel that will not ridge.
- ★ Economy and efficiency.
- ★ Construction merits your consideration.

Write for our illustrative descriptive folder

GEORGE A. STUTZ MFG. CO.

1645 CARROLL AVENUE

CHICAGO, ILL.



CLEAN 'EM FASTER *with*
RANSHOFF *Equipment*

Complete equipment for cutting down, pickling, cleaning and drying, either separately or in combination. We have built and are building equipment for the above processes on all sizes of cartridge cases, projectiles, machine gun links and Garand clips. Ranshoff Engineering Representatives located in all principal centers.

WRITE OR WIRE DEPT. "MF" FOR CATALOG OR FURTHER INFORMATION

N. RANSHOFF, Inc. TOWNSHIP AND BIG FOUR R. R.
CINCINNATI, OHIO

Electrical contact with a precise volume of the solution is established by means of a dip cell made of rubber with nickel electrodes, immersed in the bath only for a short time when readings are taken. If, for greatest convenience in taking frequent readings, it is desirable to have the conductivity cell remain constantly in the solution, then a glass conductivity cell with platinum electrodes, mounted in a stainless steel sleeve that screws into a $\frac{3}{4}$ " pipe thread in the side of the tank, is used.

Since copper sulphate has a conductivity only 1/10th that of sulphuric acid, the effect of copper sulphate proves negligible. The same checkup technique is being applied to many other industrial solution concentrations where the electrical conductivity can be translated into desired readings.

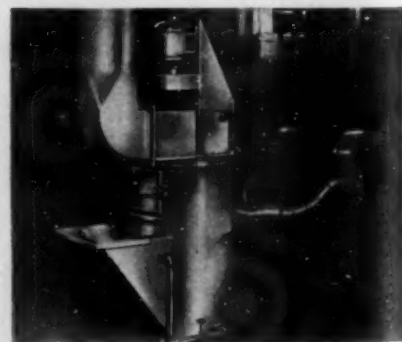
Water-Type Dust Collector

A new water type dust collector has just been introduced by the Newcomb-David Co., 5741 Russell St., Detroit, Mich. This unit, known as the "Newcomb-David Uni-Wash Dust Collector", has been designed to remove efficiently dirt, dust, lint, grindings, fumes and vapors from the air. It is particularly adaptable to grinding and polishing operations. The collector is also used in ventilating explosive ducts and hazardous operations in the finishing of magnesium alloys.

The unit is said to occupy less floor space than any similar type dust collector of equal capacity. It is solidly built of welded steel construction. All bearings are of the ball bearing cartridge type. They are ring sealed with Zerk lubricating fittings, and, like the shafts and other parts, are standard, making any necessary replacement easy and inexpensive.

The dust collector requires only one motor—a feature which contributes to low operating costs. Another economy feature is that there is no continuous flow of water. It is seldom necessary to add water to the original supply except when the sludge tank is periodically drained for cleaning.

In the operation of the unit, the air enters through an inlet pipe which can be in the back or on either side, depending on the selection of the most practical



Water-type dust collector.

location for the dust collector in relation to the equipment to which it is attached. As the air enters the unit, a powerful exhaust fan draws it, in combination with a spray from the water in the tank below, through a circular suction cone. Directly above is a revolving screen moisture eliminator which separates the water from the air. The air then passes through the exhaust fan and into the air outlet. Under average conditions, the cleaned air may be returned to the working area.

The dirt removed from the air is deposited in the sludge tank. The sludge is easily removed through a sludge removal compartment on the front of the unit—even when the dust collector is in operation.

The Uni-Wash Dust Collector is manufactured as a complete unit, for shipment to any part of the country and ready for quick and easy installation by the customer's employees or by a local sheet metal contractor.

Literature is available giving all data necessary for the proper selection of size of units exactly suited to various needs.

Direct Current Panel Board

M. E. Baker Co., 143 Sidney St., Cambridge, Mass., have announced the development of a series of panel boards containing voltmeter and ammeter for measuring of direct current.



Direct current panel board.

The assembly consists of a 10" x 6" x 1/2" thick ebony asbestos panel stock, on which is mounted a DC voltmeter with a voltage range from 0/15. Many ranges are available for the ammeter, for example, 0/100, 0/200, 0/300, 0/500, 0/750, 0/1000, and 0/1500 amperes.

These panel boards are recommended for plating barrels and plating tanks.



READY FOR ACTION!

• Fast working manufacturers of war materials are finding Wyandotte Special Metal Cleaners ready for action on every cleaning front. One of these Cleaners, for example, is tops for cleaning brass cartridge cases in all sizes after drawing and machining.

• There are countless other uses for the Wyandotte line—cleaning steel projectiles . . . bomb bodies and fins . . . fuses . . . airplane motor parts . . . pistons, crankshafts, camshafts . . . aluminum, magnesium, or their alloys . . . and many, many more—a Wyandotte Cleaner for every metal-cleaning problem, and for use in all kinds of cleaning equipment. Have your local Wyandotte Service Representative call today. No obligation.



SERVICE REPRESENTATIVES IN 88 CITIES

THE J. B. FORD SALES CO. • WYANDOTTE, MICHIGAN

METAL COLORING AND FINISHING

Hugo Krause

Consulting Chemist to Metal Finishing Industry

\$5.00

TELLS HOW . . .

- To color all types of metals and alloys
- To prepare metal surfaces for coloring
- To finish colored metals

It is comprehensive and will be of use as a reference and guide book to those engaged in metal coloring in its decorative as well as protective phases. Many of the so-called secret processes of the electroplating art are described in considerable detail with critical comments by the author.

WHAT THIS BOOK CONTAINS

Formulae and Patents	Varnishes	Metal Lacquers
Influence of Alloying on Coloring	Bronze Powders	Antiquing Imitation
Difficulties Encountered	Platinum Finish	
Preparation of Surfaces	Coloring and Protecting Iron	Brass
Rust Removal	Zinc	Silver
Grinding	Polishing	Gold
Cleaning	Waxing	Precipitating
Electrochemical Methods	Dipping	Antimony
Rubbing and Contacting Methods	Nickel	Bibliography
Copper	Gold	Cathode Treatments
Brass	Bronze	Anodic
German Silver	Aluminum	Metal Coloring
	Magnesium	Protective Coats
		Green Plating
		Chemical Metal Coloring
		Burnishing
		Phosphatizing
		Rust Prevention
		Tempering

Book Payable In Advance

Metal Finishing, 116 John St., New York

WAR WORK WANTED

FOR



Get MORE SPEED and ECONOMY
on your metal cleaning jobs.

When you CONVERT TO WAR WORK,
use COWLES CLEANERS for best results.

THE COWLES DETERGENT CO.

THE COWLES DETERGENT CO., 7016 Euclid Ave., Cleveland, Ohio

SEND DATA ON CLEANING

Name

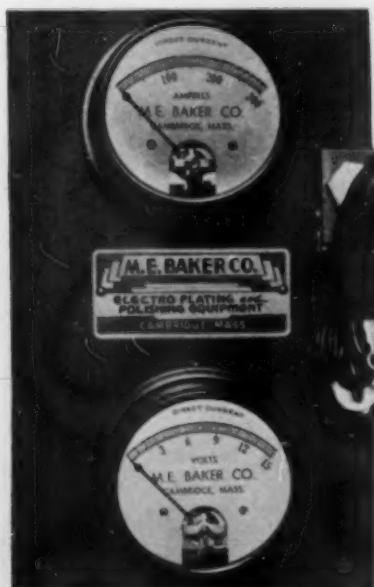
Company

Street and No.

City

State

Remarks



NEW DIRECT CURRENT PANEL BOARDS

Consisting of one DC 0/15 Volt Voltmeter and
one DC Ammeter with Shunt and Leads mounted
on 10" x 6" x 1/2" thick Ebony Asbestos Panel
Stock. Prices:

0/100 Amp. range	\$15.00
0/200 " "	17.50
0/300 " "	20.00
0/500 " "	25.00
0/750 " "	27.50
0/1000 " "	30.00
0/1500 " "	37.50

Prices F.O.B. Cambridge, Mass.

These panel boards are excellent for Plating Bar-
rels and Plating Tanks.

Guaranteed.

M. E. BAKER COMPANY

143 Sidney Street Cambridge, Mass.

Manufacturers' Literature

Air Pumps

Gast Mfg. Corp., Benton Harbor, Mich., have just issued a new loose-leaf edition of the "Gast Rotary Air Pump and Compressor Catalog". The new catalog contains concise data on the company's augmented line designed to meet especially the needs of defense production—including the new "Gast V-Belt Driven Air Pump".

In addition to illustrations and detailed descriptions of the various models, the catalog presents specifications, engineering data and performance tables for 10 sizes of pumps, 1/2 to 23 C.F.M., vacuum to 28" and pressures up to 30 pounds. Also a section of photographs and descriptions of the company's applications in industry and as standard equipment on many types of machines, is included.

The new catalog may be obtained by writing direct to Gast Mfg. Corp.

Care of Hands and Arms

The Magnus Chemical Co., Inc., has just issued a new 24-page technical bulletin entitled, "The Care and Cleaning of Hands and Arms in the Industrial Plant".

The bulletin has been written and designed for use by safety engineers, industrial physicians, industrial insurance men, plant superintendents and every plant man who is interested in or concerned with the control of industrial dermatoses.

A few of the important phases in the care and cleaning of hands and arms discussed in this bulletin are: What a hand cleaner should and should not do; safe detergents and scouring agents; germicides and medicants; lime scums and rinsing; cleaning routines; protection of hands and arms on the job. Copies of Magnus technical bulletin No. 51 can be obtained by writing to the Magnus Chemical Co., Inc., Garwood, N. J.

Electric Heaters and Heating Devices

General Electric Co., Schenectady, N. Y., have just issued a catalog entitled, "Electric Heaters and Heating Devices". This catalog describes G-E Calrod, immersion, insertion, cartridge and strip heaters. Various devices using the company's heating elements are also described. These include unit heaters, metal melting pots, glue pots and soldering irons. Twenty-seven photographs illustrate typical plant uses of the various types of heaters described.

Grinding Wheel Safety

Norton Co., Worcester, Mass., have just issued a valuable booklet entitled, "A Primer on Grinding Wheel Safety". This book, written in a catechism manner, clearly points out the factors that should be considered in the safe use of grinding wheels. It is suggested that all those having to do with the operation of grinding wheels, secure a copy of this valuable booklet.

Tables of peripheral speeds are appended to enable one to determine the peripheral speed for various R.P.M. and for wheels of different diameters.

Steam Traps

Bulletin No. 450 of Sarco Co., Inc., 475 Fifth Ave., New York, describes the company's float-thermostatic steam traps. Also described are compressed air traps and liquid level controls. Sectional drawings illustrate the operation of the various float-traps and specification information is given.

Technical Publication

"Anodizing Aluminum by the Chromic Acid Process" is the title of 21-page booklet describing the chromic acid method of anodizing aluminum as well as the equipment required and the operating details. Valuable data are given on the thickness of films obtained at various pH's, with different chromic acid concentrations and at various current densities. Valuable charts and drawings are also included to amplify the discussion. This, together with a reprint of an article entitled, "Anodic Treatment of Aluminum in the Chromic Acid Bath" can be secured free of charge by writing to the Mutual Chemical Co. of America, 270 Madison Ave., New York, N. Y.

Communications from Our Readers

Harmful Metals Used on Food Vessels

CITY OF NEW YORK
DEPARTMENT OF HEALTH
125 WORTH STREET
BOROUGH OF MANHATAN

January 17, 1942.

To the Editor:

In accordance with your request for information concerning a survey conducted by this Department relative to harmful metals used in food utensils, the following is submitted:

Section 145 of the Sanitary Code of the Department of Health of the City of New York prohibits the use of any utensil or apparatus in the preparation, storage or sale of any beverage, food or drink, which is composed of or made either wholly or in part of lead, cadmium or other metals which can be acted upon by the food or beverage so that dangerous substances are found therein. It also prohibits the manufacture and sale of food utensils containing such harmful metals.

The present National Emergency has created a scarcity in metals available for civilian use. It is especially important, therefore, that manufacturers, platers and finishers of food utensils, searching for substitutes for tin and other valuable war materials, be cautioned to make certain that such substitutes are not harmful, and are not likely to result in poisoning the

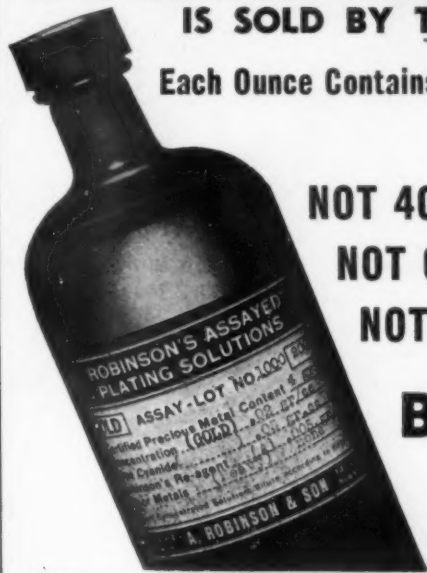
LOOK AT THIS

AND THEN AT THIS

ROBINSON'S ASSAYED GOLD PLATING SOLUTION

IS SOLD BY TROY WEIGHT

Each Ounce Contains 31.103 Grams of Pure Gold



NOT 40%

NOT 60%

NOT 80%

BUT—100%

ALWAYS

Base your comparative cost calculation on the above when buying prepared gold for plating.

MADE
BY

A. ROBINSON & SON

FOUNDED 1879

131 Canal Street, New York.

Tel. CA 6-0310 - 6-0464

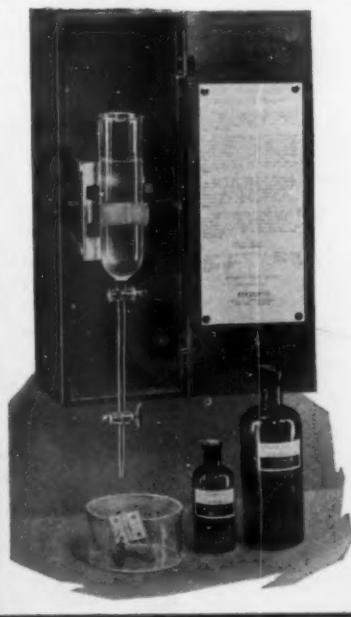
Assayers, refiners and smelters of any scrap or waste containing

PRECIOUS METALS

Full returns on rolled-gold scrap, used gold plating copper wires, discarded gold plating solutions, gold-leaf skewings, mercury.

Distributors of

**The Johnson-Matthey & Co. Inc. Well-Known
Rhodium Plating Solution**



CONTROL SOLUTIONS & DEPOSITS

METAL IS TOO DIFFICULT TO OBTAIN TO
WASTE IT

A complete line of Testing Sets for
controlling solutions and testing de-
posits.

Complete laboratory service.

Write for Leaflet

KOCOUR CO.

4720 S. CHRISTIANA AVE.
CHICAGO



Genuine BIAS BUFFS for today's buffing jobs

For 21 years BIAS Buff design and construction have been kept abreast of the times—always ready with the kind of buff that would best serve the user.

These present "emergency" days find BIAS Buffs again meeting the demand for a buff that will give better service at lower cost than any ordinary kind.

Our best reference is a long impressive list of satisfied users of Genuine BIAS Buffs. Try them in your buffing department.

*The BIAS BUFF and
WHEEL CO., Inc.*
430 Communipaw Ave.
Jersey City, N. J.



COMMERCIAL PLATERS:

There is plenty of defense work and BLACK-MAGIC is approved and accepted on government contracts for Arms, Chemical Warfare, Quartermaster and other departments.

BLACK-MAGIC processes include:

- A low temperature one bath process for steel
- A molten bath for cast iron, copper, and brass castings
- A low temperature process for aluminum bronze

An unheated bath for zinc die castings
MAGIC-ETCH for dull finishing and
WITCH-DIP a rust inhibitive final finish.

Write for portfolio containing complete information.

THE MITCHELL-BRADFORD CHEMICAL CO.
BRIDGEPORT, CONNECTICUT

food prepared or stored in vessels or utensils made from such materials.

This Department has investigated a number of outbreaks of cadmium food poisoning resulting from the use of replated second hand ice cube trays. It is suggested that METAL FINISHING inform its readers of the health hazard inherent in this situation and warn them of the use of harmful metals in the manufacture or reconditioning of food utensils.

In former years this Department also experienced considerable difficulty with second hand fountains. A number of outbreaks of food poisoning were investigated and it was found that carbonated waters from second hand fountains were the cause of these outbreaks. Examination of carbonated waters from these fountains showed considerable amounts of dissolved lead. In the refitting and rebuilding of soda fountains, it is necessary that any replaced parts or fittings be free of lead and other harmful metals. The solder used on parts of equipment that come in direct contact with the food or drink should be a tin solder free of lead.

Recently this Department has conducted a survey to determine if electroplaters, manufacturers and finishers of food utensils were plating or lining such utensils with lead. A considerable number of such utensils with lead bearing coatings were discovered and were embargoed. These utensils will not be permitted to be sold. Further, the manufacturer, plater, finisher or dealer having such utensils in his possession has violated the provisions of Section 145 of the Sanitary Code and is subject to prosecution in the Criminal Court. It is suggested that you call this matter to the attention of your readers so that they may be fully cognizant of the provisions of the law. In addition to making themselves subject to prosecution for violation of the law, there is the further consideration of the monetary loss that results from the embargo and the condemnation of such utensils.

Very truly yours,
BUREAU OF FOOD AND DRUGS
Herman Erde
Acting Assistant Director

Associations and Societies

American Electroplaters' Society Annual Convention

At a meeting held January 17, it was decided that the Annual Meeting of the Society, to be held in June, will be shortened to three days instead of the usual four. The convention will, therefore, be held June 8, 9 and 10, in Grand Rapids, Mich., and on Monday morning, the business meeting will be shortened to allow for at least

two technical papers. One technical session will be held Monday afternoon, and the usual International Good-Fellowship party will be held on Monday evening.

Tuesday morning will be devoted to an educational session and Tuesday afternoon will be for special activities, such as plant visitations, East vs. West baseball game and golf tournament. On Tuesday evening an educational session will be held.

The final educational session will be held on Wednesday morning and the usual business session will be held on Wednesday afternoon. The closing banquet will be held Wednesday night.

In view of the war emergency, it has been decided by the committee that the educational part of the program will be stressed more than ever.

Annual Branch Meetings Boston Branch

Time—Saturday, March 28.

Place—Hotel Statler, Boston, Mass.

Joe Barron, 143 Sidney St., Cambridge, Mass., General Chairman.

Newark Branch

Time—Saturday, April 11.

Place—Hotel Robert Treat.

Educational Session—2:30 P.M.

Banquet—7:30 P.M.

Personals

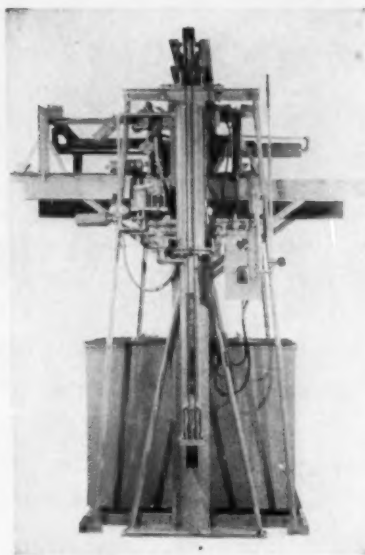
**George B. Hogaboom Appointed
Consultant on Electroplating to Bureau
of Industrial Conservation**

George B. Hogaboom, engineer of Hanson-Van Winkle-Munning Company, Matawan, N. J., was recently appointed consultant on plating and finishing of the



George B. Hogaboom

Crown Pick-up Unit



...MACHINE...

**A UNIT TYPE TRANSFER CAPABLE OF
HANDLING SEVERAL TANKS
AT ONE TIME.**

...USE...

**FOR A SERIES OF OPERATIONS WHERE THE WORK
MUST PASS THROUGH SEVERAL TANKS, AS
THE CLEANING AND RINSING OPERA-
TIONS, FOR A SEMI-AUTOMATIC
PLATING TANK.**

CROWN RHEOSTAT & SUPPLY CO.
1910 MAYPOLE AVENUE :: :: CHICAGO, ILLINOIS

DEFENSE FINISHING PROBLEMS

Our complete line of polishing and buffing compositions including greaseless compound and a laboratory with a technical staff experienced in the problems encountered in finishing defense materials, are at your service.

Upon request we will be pleased to submit samples or have a salesman call.

McALEER MANUFACTURING COMPANY
ROCHESTER MICHIGAN

McALEER MANUFACTURING COMPANY, LTD.
WALKERVILLE ONTARIO

BRANCH OFFICES
420 Lexington Ave., New York City 145—22nd Ave., San Francisco, Cal.
4014 W. Parker Ave., Chicago, Ill. 11 Scribner N. W., Grand Rapids, Mich.
1570 S. First St., Milwaukee, Wisconsin

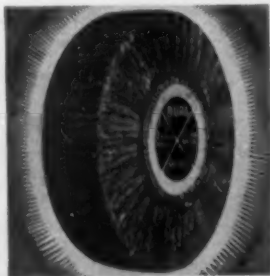
CHROMIC ACID

99.75% PURE

With two complete, independent plants at Jersey City and Baltimore, and its own supply of the basic raw material Chrome Ore from company owned and operated mines, Mutual is the world's foremost manufacturer of Chromic Acid.

BICHROMATE OF SODA
BICHROMATE OF POTASH

Mutual Chemical Co. of America
270 MADISON AVENUE, NEW YORK



A new type
WHEEL
FOR POLISHING & GRINDING
in four materials

1. leather
2. canvas
3. cotton
4. wool

We guarantee better results, lower cost per piece polished or ground, prompt deliveries. Advise us material to be polished or ground, diameter, width of wheel and arbor hole. We will give you the proper wheel for your work.

ARROW DURAWHEEL, INC.

60 GRAND STREET

WO 4-8870

NEW YORK, N. Y.

Conservation and Substitution Branch of the Bureau of Industrial Conservation.

The branch is made up of engineering consultants who are technical specialists on raw materials and act as advisors to defense agencies and industry on scarce materials and more abundant substitute materials. The branch cooperates with Material Branches in the preparation and administration of the OPM Conservation Orders. The chief of the branch is *Harvey A. Anderson* of Western Electric Company.

Mr. Hogaboom is widely known in the plating industry and has had years of practical experience, which should prove to be very valuable to the Conservation and Substitution Branch.

Detroit Rex Products Company, Detroit, Michigan, manufacturers of metal cleaning equipment and materials, announce the promotion of *W. F. Newbery* to Central Region Manager.

Robert V. Finch is the new Cowles Detergent Company representative in Northeastern Ohio and Northwestern Pennsylvania. He will handle Cowles' complete line of alkaline metal cleaners and wire drawing lubricants.

"Bob" has had many years experience in the Cowles organization—beginning in the laundry sales department and later as assistant sales manager of Cowles' Heavy Chemical Department. Since the beginning of the National Defense program, he has been devoting most of his time to metal cleaner sales and service.

Finch is married, lives in Cleveland, and will work out of Cowles' main office and laboratory there.

Business Items

Nickel Salts

In the January 1942 issue of *Metal Finishing*, availability of nickel sulphate at 13¢ a lb. was mentioned. It was not intended to mean that the company named was the only source of nickel salts at the price mentioned. Many other dealers of plating chemicals and supplies are prepared to sell nickel salts under the conditions mentioned in the January announcement, and *Metal Finishing* will be pleased to send names of such suppliers to its readers.

Oakite Expands Service Facilities

To better meet the rapidly increased needs for its services and products by metal working plants located in New England and the Southwest, *Oakite Products, Inc.*, manufacturers of industrial cleaning materials since 1909, has announced the addition of two newly created Divisions to its Nation-Wide Field Service Staff, effective January 1st, 1942. With the establishment of these two new divisions, the Company has enlarged the facilities of its service organization so that it is able to serve the metal working industry more effectively than ever before.



T. R. Smith



S. C. Shank

The New England Division, with headquarters in Hartford, Conn., at 410 Asylum Street, Room 320, Capitol Building, is headed by T. R. Smith, newly appointed Division Manager, who will supervise the activities of the eleven men comprising this division. Having served for the past 16 years as one of the Oakite Service Representatives, in an Eastern industrial area, where much of his work has been concentrated in the heavy manufacturing and mechanical industries, Smith brings to his new post a wealth of knowledge and experience in the cleaning of metals before inspection, assembly and finishing, as well as such related operations as drawing and stamping, cutting and grinding, burnishing and tumbling.

The second new Oakite Division is the St. Louis and Southwestern Division, which will make its headquarters in St. Louis. S. C. Shank, the Oakite Service Representative in the Toledo, Ohio territory since 1930, has been selected to fill the post of Division Manager and direct the activities of the twelve men comprising this division. Mr. Shank is well qualified to handle his new responsibilities, since he is equipped with a broad business background that combines diversified industrial experience with a specialized knowledge of manufacturing techniques, methods and process commonly encountered in metal forming, cleaning, finishing and fabricating operations.

While stationed in Toledo, Shank distinguished himself by his outstanding salesmanship and meritorious technical service to concerns not only in the metal working field, but also in such other industries as transportation, petroleum, dairy and food packing. In 1934 he won the Company's Service Cup, which is awarded annually to the individual in over 100 men comprising the Oakite Field Service Staff making the best sales and service record. On three other occasions he qualified for the award.

A keen believer in keeping abreast of local industrial affairs and trends, Shank is an active member of various trade organizations. Among them is the Toledo Branch of the American Electroplaters' Society, which honored him with the office of Vice President in 1941.

Recent additions to the staff of Foster D. Snell, Inc. include:

Pot Macaluso, B.S., College of the City of New York

Edgar W. Goth, B.A., Grinzing College, Vienna

Ch.E., Technical University of Vienna

Peter A. Pfeiffer, B.S., Wesleyan University

Herbert H. Watjen, B.A., Brooklyn College

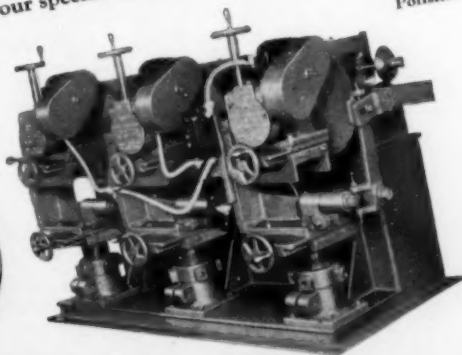
B.Ch.E., Polytechnic Institute of Brooklyn.

The ACME METHOD OF Tube and Pipe POLISHING

- ✓ INCREASES PRODUCTION
- ✓ INSURES BETTER FINISH
- ✓ at Lower Cost

Polishing costs take a licking all along the line when this Acme 3-Wheel Automatic bites into a tough job of tube or pipe finishing. It gives a three-way savings by performing three operations in one pass through the machine. Adjustable feed speeds from 0 to 20 or more feet per minute and compensating adjustments for tube size and wheel wear meet every production and finish requirement. Investigate the advantages the Acme Method has to offer you on an application to meet your specific problem. Write Acme—no obligation.

Type T-3
3-Wheel Automatic
Polishing Machine



ACME Manufacturing Co.

1642 HOWARD ST. • DETROIT, MICH.
Builders OF AUTOMATIC POLISHING AND BUFFING MACHINES FOR OVER 25 YEARS

Cutting Corners

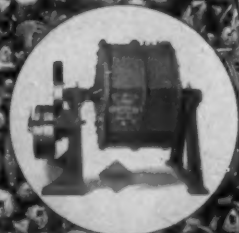
... for Top Speed Production

Rounding corners or removing burrs by grinding or filing is too slow and costly to meet today's demands for speed and economy.

Barrel finishing has solved many such problems. Write to us about yours and send a few unfinished samples of your small, metal parts. We'll gladly tell you if they're adapted to finishing with Abbott barrels and materials.

The Abbott Ball Company

1046 New Britain Ave. Hartford, Conn.



Dr. Raymond R. Rogers has been appointed chief chemist at the *Welland Chemical Works*, Niagara Falls, Ont., Can.

Dr. Rogers was formerly an instructor in chemical engineering at Columbia University, New York City, and has published papers in various technical journals including the *Transactions of the Electrochemical Society* and the *American Electroplaters' Society*.

Change of Address

International Nickel Detroit Office

In cooperation with other tenants who have consolidated their office facilities in the General Motors Building in Detroit, due to increased defense activities, *The International Nickel Company, Inc.*, announces the moving, as of January 1, 1942, of the Detroit office of its Development and Research Division from the tenth floor, Room 10-227, to the eighth floor, Room 8-217, of the same building. The telephone number remains the same.

Adel Precision Products Corp., with a plant adjacent to the Lockheed Air Terminal in Burbank, Calif., broke ground in January for its fourth expansion. The addition, which is to be completed early in March, includes plant space for production as well as expanded area for engineering research and executive offices. Approximately \$200,000 has been appropriated for the above purposes and another \$200,000 for additional machine tool and precision equipment.

H. W. Houston Co., now at 7000 Romaine Ave., Los Angeles, has construction underway on a building with 35,000 sq. ft. of floor space at the corner of Olympic Blvd. and Granville St., West Los Angeles, for use in increased production of aircraft specialties.

Flexco Manufacturing Co., 1700 East Olympic Blvd., Los Angeles, has started construction on a 4,800 sq. ft. addition for the manufacture of refrigerator units and radiator cores.

Timm Aircraft Co., which recently acquired a 54-acre site adjacent to the Metropolitan Airport at Van Nuys, Calif., has let contract for the construction of the first factory unit on the new site. The plant, with 54,000 sq. ft. of floor area, will cost \$150,000, and will be occupied by the Aeromold Division. Space in the existing building will be used for continued production of airplane parts and sub-assemblies for other aircraft firms.

Meyers & Martin Machine Co. is erecting an addition to its plant at 6920 South Central Ave., Los Angeles.

Los Angeles Magnesium Casting Co. has been established at 5531 South Riverside Drive, Los Angeles, with the *Reliable Aluminum Ware Co.* holding controlling interest. *I. J. Weinman* has been named secretary of the new firm.

New incorporations in the Southern California area during January include the following:

Dietz Panchromatic Lamp Co., 510 North Westknoll Drive, West Hollywood; *Raymond Dietz*.

Tool Engineering Co., 6601 S. Broadway, Los Angeles; *George and Mildred Hughes*, *Phillip B. Martin* and *B. A. Martin*.

Patent on Anti-Pitter

Virgil H. Waite, Berea, and Bernard P. Martin, Cleveland, Ohio, have been awarded Patent No. 2,254,161, on August 26, 1941, and the patent has been assigned to the McGean Chemical Co., Cleveland.

The patent relates to the use of surface active materials or so-called "wetting agents" to prevent pitting in a nickel plating solution. The addition agents covered in the patent claims are sulphuric esters of normal primary aliphatic alcohols having from 8 to 18 carbon atoms in the molecule. Compounds covered in the claim are sulphuric esters or their salts of lauric alcohol, myristic, cetyl and stearic alcohols.

The use of the surface active materials above described, in the presence of an organic brightener of the aryl sulphonic acid type is also covered in the patent claims. Various specific type compounds are named. The compounds so claimed as anti-pitting agents are stated to be stable during operation of the nickel solution and to not have deleterious effects on the character of the nickel plate.

These compounds have been widely used both in bright and dull nickel plating solutions in recent years.

PERMAG for Current and Still Cleaning Compounds

Widely used in Defense Industries

ing oil, surface dirt in electro automatic cleaning operations from ferrous metals.

PERMAG is quick acting, effective, economical. Let us send details.

PERMAG Cleaning Compounds are highly successful in completely removing drawing compounds, grease, stamp-

MAGNUSON PRODUCTS CORPORATION

Main Office: 50 Court St., Brooklyn, N. Y.

Factory: Third & Hoyt Sts., Brooklyn

Manufacturers of Specialized Scientific Cleaning Compounds for every Industrial Purpose.

Representatives from Coast to Coast.

Warehouses in principal cities of U. S.

IN CANADA: Canadian PERMAG Products Ltd., Montreal and Toronto



Send us your inquiries.

Tank Linings in a Hurry!

PLAST-O-LINE • easily applied • PLASTIC

No Priority Necessary

We will furnish PLAST-O-LINE lining material or PLAST-O-LINE lined tanks complete, for

PICKLING—PLATING—METAL
TREATMENT BATHS

HEIL and COMPANY

12901 ELMWOOD AVE.

CLEVELAND, OHIO



Supply Prices, January 30, 1942

Anodes

Prices are f.o.b. shipping point on quantities of from 500-999 lbs. for copper, brass and zinc. For nickel, prices are for quantities from 500-2,999 lbs.

COPPER: Cast, elliptical, 15" and longer	25½c. per lb.	ZINC: Cast, 99.99, 16" and over	16¼c. per lb.
Electrolytic, full size, 22½c; cut to size	22½c. per lb.	NICKEL: 95-97 cast, elliptical 46c. per lb., 99% plus	
Rolled, oval, straight 15" and longer 23¼c. per lb.; curved	24¼c. per lb.	cast 47c.; rolled, depolarized	48c. per lb.
BRASS: Cast, 80-20, elliptical, 15" and longer	23½c. per lb.	SILVER: Rolled, .999 fine per Troy oz.	38c. per oz.

Chemicals

These are manufacturers' quantity prices and based on delivery from New York City.

Acetone, C.P., drums, l.c.l.	lb.	.09-.178	Hydrogen Peroxide, 100 volume, carboys	lb.	.16-.18½
Acid, Boric tech., 99.5% gran., bbls.	lb.	.063	Iron Sulphate (Copperas), cryst., bbls., 1-4 wks.	lb.	.02
Chromic, 99%, 100 lb. drums, l.c.l.	lb.	.18¼	Lead, Acetate (Sugar of Lead), crystals, bbls.	lb.	.12½
Hydrochloric (muriatic) tech., 20°, carboys, wks.	lb.	.0270	Oxide (Litharge), com., powdered, bbls.	lb.	.08½
Hydrochloric, C.P., 20°, bottles	lb.	.19	Magnesium Sulphate (Epsom Salts), tech., bbls.	lb.	.018
Hydrofluoric, 30% bbls.	lb.	.06-.06½	Mercury Bichloride (Corrosive Sublimate), crys.	lb.	\$2.39
Nitric, 36°, carboys 1-9, wks.	lb.	.0595	Mercuric Oxide, tech., red, powder, bbls.	lb.	\$3.26
Nitric, 42°, carboys 1-9, wks.	lb.	.0745	Nickel, Carbonate, dry, bbls.	lb.	.36-.36½
Oleic (Red Oil), distilled, drums	lb.	.12¼-.14	Chloride, bbls.	lb.	.18-.20
Oxalic, bbls. l.c.l.	lb.	.14½	Salts, single, 425 lb. bbls.	lb.	.135-.145
Stearic, distilled, double pressed, bags	lb.	.15-.16½	Salts, double, 425 lb. bbls.	lb.	.135-.145
single pressed, bags	lb.	.14½-.16	Paraffin, refined, bgs., 123-125 a.m.p., c.l.	lb.	.0520
triple pressed, bags	lb.	.17¼-.19¼	Perchloroethylene, drums, l.c.l.	lb.	.08½
Sulphuric, 66°, carboys 1-9, wks.	lb.	.0245	Phosphorus, red, cases	lb.	.44
Alcohol, Amyl (Fusel oil, ref'd), l.c.l., drums	lb.	.18-.18½	yellow, cases	lb.	.23-.25
Butyl-normal, l.c.l., drums	lb.	.13½-.168	Potash, Caustic, 88-92%, flake, drums, works, c.l.	lb.	.07
Denat., S.D. #1, 190 pf., 1-18 drms., wks.	gal.	.35½	Potassium, Bichromate, crystals, casks	lb.	.10
Diacetone, tech., drums, l.c.l.	lb.	.11-.13½	Carbonate (potash) calc., wks., drums	lb.	.06¼
Methyl, (Methanol), 95%, drums, l.c.l.	gal.	.58½	Cyanide, 94-96%, dom. dms., wks.	lb.	.55
Propyl-Iso, 99%, drums, l.c.l.	gal.	.47	Pumice, ground, 1½ F. & coarser, bbls., wks.	lb.	.04½
Propyl-Normal, drums, wks.	gal.	.67-.70	Quicksilver (Mercury), dom. 76 lb. flasks, net	flask	\$203.-\$210.
Alum, ammonia, granular, bbls., works	lb.	.04	Rochelle Salts, crystals, bbls.	lb.	.44
Potash, granular, bbls., works	lb.	.0425	Rosin, gum, D bbls., dock	lb.	.0365
Ammonia, aqua, 26°, carboys	lb.	.05¼	Silver, Chloride, dry, 50 oz. lots	oz.	.38¾
Ammonium, chloride (sal-ammoniac), white, granu- lar, bbls., wks.	lb.	.0675	Cyanide, 100 oz. lots	oz.	.34
Sulphocyanide (thiocyanate), pure, crystal, kegs	lb.	.55	Nitrate, 100 oz. lots	oz.	.27¼
Sulphocyanide (thiocyanate), tech., kegs	lb.	.40	Sodium, Carb. (soda ash), light, 58%, bags	lb.	.0213
Antimony Chloride (butter of antimony), sol., carboys	lb.	.17	Cyanide, 96%, dom. 100 lb. drums	lb.	.15
Barium Carbonate, pptd., bags, l.c.l., works	lb.	.03	Hydroxide (caustic soda) 76%, flake, l.c.l.	lb.	.0490
Benzene (Benzol), 90%, drums, works	gal.	.20	Hypsulphite, crystals, bags, wks.	lb.	.0250
Butyl Lactate, drums	lb.	.265	Metasilicate, granular, 1-9 bbls.	lb.	.0335
Cadmium Oxide, l.c.l., bbls.	lb.	.95	Nitrate, rfd., gran., bbls., wks.	lb.	.029
Calcium Carbonate (Pptd. chalk), c.l., wks.	lb.	.027½	Phosphate, tribasic, tech., bbls., wks.	lb.	.038
Carbon Bisulphide, l.c.l., 55 gal. drums	lb.	.05¼	Pyrophosphate, anhydrous, bags, l.c.l.	lb.	.0660
Carbon Tetrachloride, l.c.l., drums	gal.	.80	Sesquisilicate, 1-9 drums	lb.	.0430
Chromic Sulphate, scale, 100 lb. drums	lb.	.45	Stannate, drums	lb.	.365
Cobalt Sulphate, drums	lb.	.71	Sulphate, anhydrous, bbls., works	lb.	.0215
Copper, Acetate (verdigris), bbls.	lb.	.26	Sulphocyanide, drums	lb.	.55-.65
Carbonate, 52-54%, bbls.	lb.	.16½	Sulphur, Flowers, U.S.P., bbls., l.c.l. mine	lb.	.039
Cyanide, Tech., 100 lb. bbls.	lb.	.34	Tin Chloride, crystals, kgs.	lb.	.39-.39½
Sulphate, 99%, crystals, bbls., 1-5	lb.	.0535	Toluene (Toluol), 2°, ind., drums, works	gal.	.33
Cream of Tartar (potassium bitartrate), gran., kegs	lb.	.58½	Trichlorethylene, drums, l.c.l., zone 1	lb.	.08½
Crocus Martii (iron oxide) red, bbls.	lb.	.03¼	Tripoli, air floated, bgs., c.l., wks.	ton	\$21.00
Dibutyl Phthalate, drums, l.c.l.	lb.	.215-.235	Wax, Bees, white, bleached, slabs, 1-5 cases	lb.	.58
Diethylene Glycol, drums, l.c.l., works	lb.	.155	Bees, yellow, crude, Brazil, 100 lbs.	lb.	.50
Dextrin, white, bags, F.O.B. Chicago	lb.	.0395	Carnauba, refined, bags	lb.	.85
Emery (Turkish)	lb.	.08	Montan, bags	lb.	.45-.46
Ethyl Acetate, 85%, l.c.l., drums, works	lb.	.12-.13	Spermaceti, blocks	lb.	.24-.25
Ethylene Glycol, l.c.l., drums, works	lb.	.15½-.18½	Whiting, precipitated, bags, l.c.l.	ton	\$18.-\$22
Monoethyl ether, dms., l.c.l., wks.	lb.	.15½-.16½	Xylene (Xylol), ind., returnable drums, works	gal.	.32
Gold, Chloride, yellow, bottles	oz.	\$19.25	Zinc, carbonate, tech., bbls.	lb.	.20
Cyanide, potassium 41%, bottles, wks.	oz.	\$14.20-\$14.95	Cyanide, 100 lb. kegs	lb.	.37
Gum, Arabic, white, powder, bbls.	lb.	.22-.24	Chloride, tech., granular, drums, c.l., wks.	lb.	.08
			Sulphate, crystals, bbls., l.c.l.	lb.	.039



*... works better
than old one 6 times its size!*

"Frankly, I was worried when I saw the little Sarco Float-Thermostatic Trap shipped us for our big dryer, until I tried it. It's O.K.—in fact better than the old trap. Now I have learned that the outlet is the thing that counts. Glad we won't have to lug those big jumbos around the plant any longer."

ALL-OUT PRODUCTION WITH SARCO

Idle condensate is a menace that fast acting Sarco Steam Traps eliminate. Get the right type of Sarcos in the right spots all over your plant and you will get the speed, security and economy of production you are entitled to.

107

SARCO
SAVES STEAM

SARCO COMPANY, INC.
475 Fifth Avenue, New York, N. Y.
SARCO CANADA LTD., TORONTO, ONT.



POLISHED and BUFFED

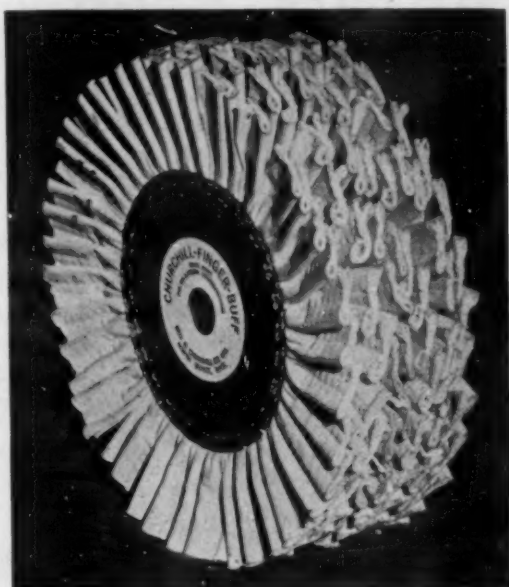
today's efficient method used by progressive manufacturers in doing their part to Aid National Defense.

There's a Packer-Matic for your particular product. Save time, money and increase your production.

Three different types of Packer-Matic
—Write for descriptive literature.

AUTOMATIC POLISHING & BUFFING MACHINES
Packer-Matic
THE PACKER MACHINE CO., MERIDEN, CONN., U.S.A.

102



CHURCHILL FINGER-BUFFS

SELF COOLING—FAST CUTTING

FOLDED FINGER EDGE gives LONG WEAR

AVAILABLE in SOFT, MEDIUM and HARD grades

Try a set for FASTER Production and LOWER COSTS

GEO. R. CHURCHILL CO., Inc., No. Quincy, Mass.

WOOD TANKS



The shortage of metals has increased the demand for wood tanks for plating and pickling service. We can give excellent service on all types of tanks. Send us your inquiries.

KALAMAZOO TANK & SILO CO.

508 Harrison St., Kalamazoo, Mich.

NICKEL SILVER

Sheets—Rolls

Phosphor Bronze, Bronze Gilding Metal
Low Brass and Special Alloys

WATERBURY ROLLING MILLS, Inc.

Waterbury, Conn.

METAL FINISHING, February, 1942